ENGINEERING NEWS

THE PENNSYLVANIA RAILROAD COMPANY, it is probably safe to say, is the greatest corporation in the world in point of annual receipts and expenditures. The annual report just issued shows the following results on the whole system, which now comprises 7,581 miles of railway and 12,510 miles of track:

	1888	1887	Increase.
Gross earnings	$116,509,292	$113,515,506	$993,786
Gross expenses	80,737,335	77,238,082	3,499,253
Net earnings	35,771,957	38,277,424	D 2,505,467
Tons freight moved	113,346,894	106,128,215	
Tons fr't moved 1 mile	10,593,182,898	9,922,067,014	
Total passengers	74,099,066	68,153,705	
Total pass. miles	1,463,539,998	1,332,772,904	

The principal new undertakings planned for the present year are: the construction of a bridge over the Ohio river just west of Pittsburg, at a cost of about $1,500,000, in order to avoid the transfer of through freight over the terminals in the cities of Pittsburg and Allegheny; the provision of yards and transfer facilities at a point about 14 miles east of Pittsburg where traffic from the west will be transferred to the main line; the removal of grade crossings in the important cities reached by the system; and the erection of shops at Altoona to be devoted exclusively to building new locomotives.

THE ARCADE RAPID TRANSIT PROJECT, proposing to tunnel under Broadway, New York, has been killed by an adverse decision of the Court of Appeals in the case of JOHN JACOB ASTOR and others vs. the New York Arcade Railway Co. The company traced its corporate existence to the Beach Pneumatic Transit Co., organized in August, 1869, to lay down and maintain one or more pneumatic tubes underground for the conveyance of "letters, parcels, packages, mails, and merchandise," in said tubes. The act fixed the maximum interior diameter of the tubes at 54 ins. Except the construction of a short experimental tunnel, nothing was done by this corporation, but to change its name in 1874 to that of the Broadway Underground Railway Co., and in 1884 to that of the Arcade Railway Co. The judges now decide that the title is insufficient, and the act of 1873, proposing to authorize the Beach Pneumatic Railway Co. to construct underground railways, is unconstitutional and void, and all subsequent legislation based upon it falls. In other words, this company never had a legal right to transport passengers. The judges very properly conclude by saying that if such a road is desirable, it should be placed upon a constitutional basis and make an undisguised appeal upon its merits for the public sanction.

A NEW RAPID TRANSIT COMMISSION for New York City is the object of a bill now in preparation by the Corporation Counsel. The five members are to be appointed by the Mayor, and are to have power to lay out routes without regard to the plans of previous commissions. It is to sit continuously after the passage of the bill and to make an early report.

DOCK BUILDING, for the better accommodation of shipping at the port of New York, seems to be imperatively necessary, according to the late remarks of President POST, of the Department of Docks. The sea-wall system proposed by Gen. MCCLELLAN for the North river side has been outgrown in 20 years, and an extension of the frontage by projecting piers would result in obstruction and current deflection. The plan now is to acquire land and extend West St. in a straight line and with a uniform width of 250 ft. and build new piers within the line of the sea-wall. The estimated cost to the city is $9,000,000; but the estimated revenue from the new piers would pay 8 per cent. on the outlay. A bill is now before the Legislature to authorize this change of plan.

A GREATER NEW YORK is the object of a bill introduced in the New York Legislature on March 12. This the old project of Mr. ANDREW H. GREEN, is extending the present limits of New York so as to include Brooklyn, Kings Co., and parts of Queens, Richmond, and Westchester counties. The bill proposes to appoint a commission of five to consider this project in all its bearings and to report their conclusions to the Legislature.

BROOKLYN WATER-WORKS EXTENSION is stirred up again by Mayor CHAPIN of that city in a letter of March 11. He says there is no apparent reason for the continued refusal of the Alderman to take action in this matter. Property costing $432,000 was bought four years ago covering water rights and lands extending from Rockville Center to Massapequa; but this property remains unused and valueless, awaiting further action of the Aldermen. Plans were prepared for these works by Chief Engineer VAN BUREN in 1885, and forwarded with estimates and all information to the Aldermen. The matter was then referred to the Water and Drainage Committee, but absolutely nothing has been done since then.

THE HUDSON RIVER TUNNEL is thus briefly outlined in its corporate history by Mr. HENRY S. WHITE, its counsel. Articles of incorporation were filed in New Jersey in 1873 and a shaft started; but this was followed by six years of litigation with the Delaware, Lackawanna & Western R. R. and the Jersey Shore Improvement Co. for possession of the ground. An injunction procured in 1874 delayed all work until 1879, on the ground that the tunnel company could not be incorporated under the general railroad law. The toughest legal problem encountered was the condemnation of the land required, which belonged to the Delaware & Lackawanna R. R. Co. The opposition presented decisions to prove that land necessary to the franchises of any existing corporation could not be condemned by a company organized under the general railroad law. This objection was finally successfully met by condemning the land below the surface of the ground. Actual work was commenced in September, 1879, and stopped in July, 1883, owing to the death of TRENOR W. PARK, who, with Senator JOHN P. JONES, of Nevada, was the principal stockholder. Work was recommenced twice since then simply to demonstrate the feasibility ot the methods. The principal stockholders now are said to be Senator JONES, D. O. MILLS, and ROSCOE CONKLING'S estate.

THE HUDSON RIVER TUNNEL LOAN of $1,500,000, referred to last week, is reported to has been subscribed for twice over in London. HENRY S. WHITE, the counsel for the company, is reported to have made the statement that "the contracts will probably be given to Messrs. ANDERSON & BARR and to MILES TIERNEY." Mr. ANDERSON, of the above firm, was the general superintendent under whom most of the present tunnel was built.

THE PROPOSED WINNER BRIDGE, over the Missouri river at Kansas City, is thus described by the *Times* of that city. It will be built of iron and steel, have two 270-ft. and four 420-ft. spans, with 57 ft. headway above high water under the bridge. In width it will provide for one standard-gauge railroad track, two street or motor lines outside the main trusses, and two foot-ways. The total length, including approaches, will be 7,050 ft. The piers will be of masonry founded on pneumatic cassions, carried down 50 to 88 ft. below the water surface. Rumor has it that this bridge will be utilized by the Chicago & Northwestern R. R. as an entrance to Kansas City, and also used by a dummy line leading to land of Mr. WINNER, located 14 miles north of the city. The estimated cost of the bridge is $1,000,000, and the engineers are Messrs. WADDELL & JENKINS, of Kansas City.

FAST TRAIN SERVICE between Chicago and Kansas City has been resumed on the Chicago & Alton and Chicago, Burlington & Quincy lines, and the Rock Island is to follow on March 17. It is reported that the move is strongly opposed by the Wabash managers, their road not being able to compete in point of time.

THE PACIFIC SHORT LINE project, described on our editorial pages, is to be rapidly pushed. At a meeting held at Sioux City, Ia., March 12, $1,000,000 was paid in for use of the Construction Company, and L. F. WAKEFIELD, of Sioux City, was appointed Principal Assistant Engineer. Contracts for grading the first 100 miles are to be let very soon.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was the derailment, on March 10, of the front engine of a freight on the Philadelphia & Reading road, near Mahanoy City, Pa. The train had an engine at each end. The accident is attributed to a broken frog. Two men were killed and two injured. Several cars were wrecked.——Another serious accident occurred on the Grand Trunk road, near Lucan, Ont., on March 11. One of the cars of a passenger train was noticed to be jolting very badly and the conductor had signaled the engineer to stop, when 2 cars left the rails and went over an embankment 30 ft. high; one car, containing 16 passengers, turned over in its fall, but although several persons were injured, none were killed. About 10 persons were injured. The accident is attributed to a broken wheel.

BRIDGE ACCIDENTS are reported as follows: On February 25, a wooden highway bridge near Pine Grove, Idaho, gave way under a stage coach and some of the passengers were with difficulty rescued from drowning. The structure was probably very roughly built.——On March 10, a freight train on the Erie road went through the pin-connected iron bridge over Cayuga creek, near La Salle, N. Y., the engine and one car got safely across, but 11 cars went into the creek. No lives were lost, as the caboose kept the track. The bridge is of iron, of about 100-ft. span, and is reported to have been rebuilt recently. A rail broke just before the train reached the bridge, probably under the engine. There were no rerailing guards.

EARTHQUAKE SHOCKS were felt March 8, in Pennsylvania, Maryland, and Delaware. In some places the shocks were strong enough to break windows and overthrow chimneys.

THE WIND PRESSURE ON THE FORTH BRIDGE, or rather the effective area of the bridge exposed to a wind pressure striking the work at different angles, was practically demonstrated by Mr. B. BAKER, as described in a late lecture before the Society of Arts, as follows:—A model of the bridge was made, and towed in water at different angles to the stream; the area of a flat board normal to the current was then determined, which exerted the same drag as the model; this area was then taken as the effective area of the bridge for the particular angle at which it was towed.

THE LONDON METROPOLITAN BOARD OF WORKS, which is about being superseded by a County Council, reviews in its last report the work accomplished by it in the 33 years of its existence. The most important was the main drainage system (1858-1865) which cost $23,000,000 and has an average daily sewerage discharge of 160,000,000 galls. The Thames Embankment (1862-1870) came next in importance, and cost $5,784,900. The Albert Embankment 4,300 ft. long, was commenced in 1866, and completed in 1869 at a cost of $5,072,700. The Chelsea Embankment (1871-1874) cost $1,349,955, and in addition many streets have been widened or created. To house the people evicted in making these improvements the Board built 324 blocks of houses accommodating 38,200 persons. It spent about $7,500,000 under the Artisans and Laborers' Dwellings Improvement Act, and over $6,000,000 for freeing the bridges. It has also created or secured the control of 3,679 acres of parks and commons.

THE AVAILABLE COAL SUPPLY OF ENGLAND, according to a late paper by R. PRICE-WILLIAMS, M. Inst. C. E., is 97,525 millions of tons, including the deposits of Scotland and Ireland. The total output in 1887 was 162,120,000 tons. Of this total the manufacture of iron and steel consumes a large percentage. In 1869, 32,500,000 tons were so consumed, or nearly one-third of the coal output of that year. But since then great economies have been effected in this branch of national industries. In 1830, 7 tons of coal were used in making 1 ton of pig-iron; in 1869 this had been reduced to 3 tons. 7 cwt.; and in 1881, only 2 tons, 3 cwt. of coal were used for each ton of pig produced. About 23½ per cent. of all coal mined is consumed in producing power for manufactures; steam, navigation, foreign and coasting, consumed in 1887, 13,750,000 tons, and the railways used in the same year 6,000,000 tons. The coal exported in the last year amounted to almost 27,000,000 tons, the export having doubled in 17 years, and domestic consumption required 26,250,000 tons. The author estimated that unless further great economies were effected, the present coal fields of the United Kingdom would be exhausted in 192 years.

THE COPPER OUTPUT OF THE UNITED STATES in 1888, as estimated by Mr. C. KIRCHOFF, Jr., of the U. S. Geological Survey, was 230,403,581 lbs., of which 225,494,425 lbs. were domestic copper, and the remainder from imported ores and pyrites. The output of 1887 was exceeded by nearly 46,000,000 lbs. The total production of spelter in the United States in 1888 was by the same authority 55,913 tons of 2,000 lbs., against 50,340 tons in 1887, and it was larger than any year since 1882.

THE SOCIÉTÉ TECHNIQUE DE L'INDUSTRIE DE GAZ, in France, has offered a prize of 3,000 francs for the best essay on ventilation of buildings and dwellings lighted by gas, and the committee of the society especially desires to secure exact experimental data on the subject, as much of that already in existence is thought to be faulty. To this end it is not required that each essay shall cover the entire ground, but a competitor may take one of the following topics: 1. Basis and principles of ventilation in general, including the study of experimental data upon which all systems of rational ventilation rest, carbonic acid, aqueous vapor, temperature, etc. Systems of ventilation in different countries; automatic ventilation of dwellings; and ventilation in winter, both by heated and unheated air. 2. Experimental data on the utilization of burning gas for lighting or heating as a means of ventilation. (*a*) Ventilation properly speaking. (*b*) Special study of ventilation. 3. Complete study of an existing system of ventilation by the combustion of gas.

WATER-WORKS SYSTEMS are being established in Chili, and several new works are mentioned in the Chilian papers. A tank system for fire protection is being established at Pisagua, similar to the system at Iquique, and Mr. CHAS. WURTH has offered to supply the latter city with water, at 1 ct. per decalitre, if granted an exclusive privilege for as long as no one offers to supply it at a lower rate. The Tarapaca Water-Works Co. has also made another offer to the municipality. Plant and estimates prepared by Mr. VALENTINE MARTINEZ for supplying Yungon with water have been accepted by the Government; the engineer's estimate of cost is $7,077.59. The Government has also accepted the plans and estimates prepared by Mr. A. RIED, for supplying Anjeles with water from a spring at a cost of $66,534. Work has been commenced on the system for bringing water to Antofagasta from the Loa river. Trouble with the water supplies is also beginning, for it is reported that there is danger of the wells of the water-works at Salto being contaminated by drainage from the town.

RAILWAY GAUGES IN ASIA are various. The British Indian roads, with a collective length of 12,366 miles, for about 7,450 miles have a gauge of 5 ft. 5⅝ ins., the remainder being divided among 6 gauges from 2 ft. to 4 ft. Of the narrow gauges the most prevalent, embracing 4,200 miles, is the metre, 3 ft. 3⅜ ins. The Ceylon railroads have the standard Indian gauge. The Russian trans-Caspian lines have the Russian standard gauge of 5 ft. In Asia Minor, the line Mudania Brussa has a gauge of 3 ft 7¼ ins. The island of Java has 449 miles of 3 ft. 6 ins. gauge, and 126 miles with 4 ft. 8½ ins. In Japan, with the exception of an 8-mile piece begun in 1885, with a gauge of 2 ft. 9 ins., all the roads have a 3 ft. 6 ins. gauge. In Africa, the Egyptian railroads, amounting to 932 miles, are of the 4 ft. 8½ ins. gauge. Algiers and Tunis, with 1,203 miles, in 1884, had the 4 ft. 8½ ins. standard on all except 155 miles, which had a 3 ft. 7¼ ins. gauge. The English Cape Colony had, in 1885, 1,522 miles, all of 3 ft. 6 ins. gauge.

THE TICKET COMMISSION ABUSE seems likely to be wiped out at an early day. Chairman COOLEY hit the practice about the worst blow it has received, in the following letter to Vice-Chairman DANIELLS, of the Central Traffic Association:

I understand that the railroad companies at Chicago are beginning to pay commissions again. I have only to say on this subject at this time that if that course is adopted and persisted in, it will be necessary that it be taken up at a public hearing at Chicago in which the question to be presented will be the reduction of the passenger tariffs of all the roads paying commissions to the extent of the commissions they are found to be paying.

It will be well for the managers of these roads to consider what the inevitable effect of such an investigation must be. With what face they can contend against legislation for the reduction of their rates when they themselves are reducing them in this indirect way—and in a way, too, that results in a much greater reduction of their revenue that the actual amount paid out for commissions would indicate—is more than I can understand. At any rate, I desire that they should keep clearly before them in what they do now a consequence that may speedily be upon them. If they want to resuscitate the business of the scalpers, with all its rascalities and with all its losses to themselves, they can of course do it; but they should be prepared to take the consequence that may follow from unfriendly legislation, as well as from the action of other public authorities.

Respectfully yours, T. M. COOLEY.

AT A JOINT MEETING OF TRUNK LINE REPRESENTATIVES and lines of the Central Traffic Association at Commissioner FINK'S office in this city, resolutions were adopted in which each company pledged itself to discontinue the payment of commissions in every form, to forbid its agents to receive them, and to request all lines with which any through ticket arrangements were in force to refrain from paying commissions. If any company ventures to disregard this pointed warning, action is to be taken before the Interstate Commerce Commission.

THE WESTERN UNION TELEGRAPH CO. have removed 135 poles and 300 wires since Jan. 1, 1889, by placing wires and cables on the elevated structures in this city. The company is now engaged in laying further cables on the elevated road in Sixth Avenue, and shortly expect to remove all the poles on that avenue north of 23d St. and all on Broadway between 14th and 34th Sts.

THE ALBANY CEILING INVESTIGATION, now in progress, shows that the money drawn on vouchers approved by the Superintendent amounts to $119,745.75 over a fair price for material and labor. The pay-roll shows about 25,000 days' labor which was not performed. According to the vouchers, 400 men were constantly employed, though there was not room enough for this number to even stand around on the scaffolding.

HON. ALDACE F. WALKER, of the Interstate Commerce Commission, has accepted the position of Chairman of the Interstate Railway Association. He will receive a salary of $25,000, and the members of the Association have guaranteed him this for a term of three years. The Association promises to be a most important factor in Western railway affairs.

THE TUNNEL at Cumberland Gap is open 1,150 ft. on the Tennessee side and 1,050 on the Kentucky side, with 1,550 ft. yet to open. The contractors expect to have the work completed long before the specified time.

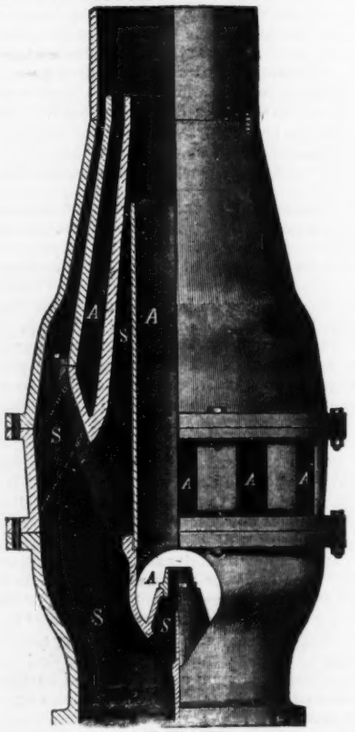
Our New Naval Machinery.

Ex-Secretary WHITNEY left the report of the test of the *Yorktown* to be acted on by his successor, but added the following interesting and gratifying note, the statement as to the horse-power developed per ton of machinery being especially notable:

The results of the trial of the *Yorktown* are satisfactory, but final action may with propriety be taken by my successor. The conditions of the trial which the *Yorktown* has been subjected to are much more severe than those required in any previous trial. Upon the recommendation of the Chief of the Bureau of Steam Engineering, rules have been adopted for these trials, under which, for the first time, the horse-power developed both by main and auxiliary machinery is accurately tested, cards being taken with such frequency as to leave no possible opportunity for any error. This trial has been made at sea instead of in smooth water. The results of this trial are most creditable to the contractors. The effective power which they were required to produce and guarantee was more than double that exacted previously from contractors of the department. Until the contract for the *Yorktown* was entered into, the standard of the department had been 5 H. P. per ton of machinery, and of the four ships built under that standard two failed to reach even that result, and were accepted by the department notwithstanding. The *Yorktown*, with 330 tons of machinery, has produced upon the trial 3,398 indicated horse power—more than 10 H. P. per ton of machinery—and as speed is directly dependent upon this consideration, its importance to the department cannot be overestimated. It would be entirely proper for the vessel to be accepted, reserving $10,000 as security for the small matters yet unfinished, but it is perhaps better to leave the matter to my successor.

Triple-Expansion Exhaust Pipe.

The Smith triple-expansion exhaust pipe for locomotives, which we illustrate this week, is the invention of Mr. JOHN Y. SMITH, the originator of the Smith vacuum brake. In this pipe the flow of the exhaust steam is not restricted after it leaves the cylinder, the discharge orifices being as large as, or larger than, the passage in the cylinder. The steam is mingled with the heated air and gases in the smoke box, and as these gases are at a much higher degree of temperature, the steam is superheated and expanded, and a continuous, steady blast is claimed to be thus maintained.



Triple-Expansion Exhaust Pipe for Locomotives.

The right-hand side of the cut shows the pipe in elevation and the left-hand side shows it in section; *S S* are the passages for steam, and *A A* the passages for air and gases. At the bottom of the pipe is an opening, in the center of which is a 1-in. exhaust nozzle, the blast from which draws in the hot gases, and discharges them, mingled with the steam, through the central pipe. The outer circle is also a steam nozzle, 9 ins. outside diameter, and having an opening of ⅝-in. or an area of 16 sq. ins.; the second circular opening is for cinders and gases only, has an opening 1-in. at the top, and has at the bottom the openings *A A* all around the largest part of the stand; the third opening is 5⅝ ins. outside diameter, and has an opening at top of ⅝-in. containing 6 sq. ins. of area. The combined area of the three exhaust openings is 28½ sq. ins., which would be equal to a single nozzle 5⅜ ins. in diameter, or a pair of double nozzles, each 3¾ ins. in diameter.

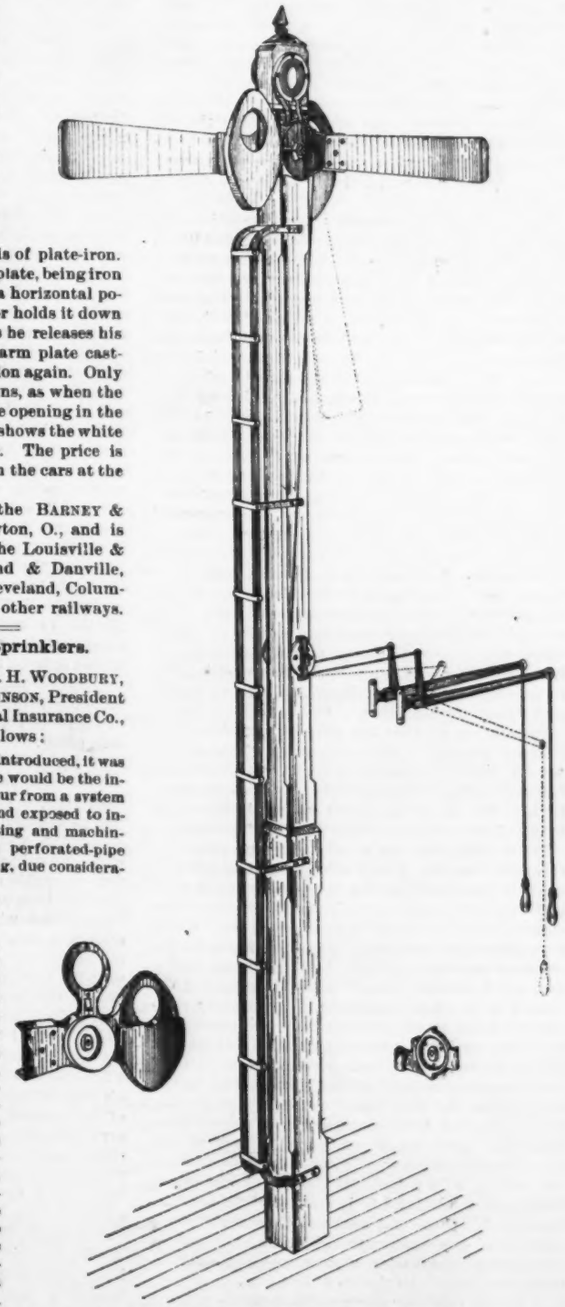
The advantages claimed are: reduction of back pressure to a minimum; prevention of the ejection of sparks from the smokestack; almost complete absence of noise from the exhaust; keeping the flues and smoke box clean. The deadening of the noise from the exhaust would seem to make this device well adapted for city and elevated lines. The pipe has been in use for some months on the Boston & Maine, and some more engines of this road have recently been equipped; it is also in use on the Wabash Western. It is manufactured and supplied by the Smith Exhaust Pipe Co., of Doylestown, Pa.; General Manager, JOHN Y. SMITH; Secretary and Treasurer, HENRY LEAR.

The Harrington Semaphore Signal.

The special feature of this signal, of which an illustration is given, is that the arm always stands at the "danger" position unless the operator holds the lever back to lower it to indicate "track clear," and as soon as he releases the lever, the arm returns to its normal position indicating danger, thus obviating any carelessness on the part of the operator in putting the signal in this position.

The signal may be made of any desired size. The standard height of post used is 25 ft., allowing 4 ft. to go in the ground, thus bringing the lamp to about 21 ft. above the ground. The blade or arm is 55 ins. long from the pivot on which it works, and is 9 ins. wide at the outer end. The levers are made of malleable iron; the arm plate shown is the lower left-hand corner of the cut is made of cast-iron, except the little arm holding the lens, which is of plate-iron. The ladder is wrought-iron; the arm plate, being iron and quite heavy, holds the blade in a horizontal position at all times, unless the operator holds it down by means of the lever, and as soon as he releases his hold on the lever, the weight of the arm plate casting brings it back to the danger position again. Only one lens is used, that being the red lens, as when the arm is dropped for "track clear," the opening in the arm plate comes before the lamp and shows the white light directly through the opening. The price is $36.25, ready for erection, delivered on the cars at the factory.

The signal is manufactured by the BARNEY & SMITH MANUFACTURING CO., of Dayton, O., and is being made in large numbers for the Louisville & Nashville, Pennsylvania, Richmond & Danville, Cincinnati, Hamilton & Dayton, Cleveland, Columbus, Cincinnati & Indianapolis and other railways.



The Harrington Semaphore Signal.

Accidents from Automatic Sprinklers.

A recent special report by Mr. C. J. H. WOODBURY, Vice-President to Mr. EDWARD ATKINSON, President of the Boston Manufacturers' Mutual Insurance Co., on this subject, is in substance as follows:

When automatic sprinklers were first introduced, it was anticipated that excessive water damage would be the inevitable result of accidents liable to occur from a system of pipes connected to a water supply, and exposed to injury from freezing, and mishaps to belting and machinery. The numerous accidents from perforated-pipe sprinklers tended to create such a feeling, due consideration not being given to the difference in condition between these two systems of fire apparatus.

Automatic sprinklers have been in sufficiently long service to make a record establishing their value in the efficient protection of property, showing by the experience of this company that the average loss from fires where they formed a portion of the apparatus in service amounted to only 6 ¼ per cent. of the average loss where such apparatus was not in service; and it was considered that enough time had elapsed to give an experience of similar value in regard to the damage by accidents resulting from automatic sprinklers. A circular of inquiry was sent to those insured in the Factory Mutual Insurance Companies, asking questions relative to the character of accidents to automatic sprinklers, and requesting the experience in regard to injury ensuing from various accidents to the system, together with estimates of the amount of damage resulting from these accidents and also inviting criticism and suggestion upon automatic sprinklers.

Replies were received from 639 mills, representing 811 different sprinkler plants, up to the time when the compilation for this report was made. In addition to this, 20 replies were so informal as not to be of any use, and 9 reported that there were no automatic sprinklers on their property. Replies were not received from 631 establishments; and inquiry, which was made in a number of these instances, disclosed the fact that replies were not made because there had not been any accidents, and it was assumed that it was unnecessary to send answers if there were no accidents to report.

The following tabulation shows the results in detail, indicating among other things a water damage of $2.56 per year for each sprinkler plant in service, and $3.25 for each establishment per year. If the 631 who did not reply were silent because of lack of accidents (and we have no evidence against this assumption), the annual water damage from accidents to sprinklers would be reduced to $1.63 for each mill.

These results show that the damage from accidents to automatic sprinklers has been nominal in amount, and is less in comparison than that from other forms of apparatus. It was formerly a frequent occurrence for the pump inspectors to report damage from perforated sprinklers while the pumps were being tried during the summer months; the valves being open when the pump was started, or they were opened when it was supposed that they were being shut. At fires the perforated sprinklers have been put out of service by turning a valve in the right direction until the stem of the valve was broken. There was often excessive water damage, not only from opening the wrong sprinkler valve, but also in several instances from opening all of the valves, and thus wetting down the whole mill for a slight fire. In one instance a mill was wet down by a person who mistook the moonshine on the windows for a fire within; and since this report was being compiled, a laborer in a mill yard, while intending to draw a bucket of water from a hydrant, turned the wrong valve, and wet down a room equipped with perforated sprinklers. These accidents have by no means been confined to irresponsible persons, as an instance has been known where the agent of a mill wet down a large carding room while in the act of illustrating to the president of an insurance company how easily the valves of his fire apparatus worked.

Perforated sprinklers have also been rendered inoperative by the closing up of the orifices by felted cotton dust, by rust, and by foreign matter in the water. In any event, by distributing the water over a large area instead of concentrating it where it was needed, they have not always been as efficient as desired in extinguishing fires and their use has been attended with excessive water damage. It is important that there should be a pressure gauge in connection with every automatic sprinkler system. An automatic sprinkler system should not be flushed, because all water is corrosive in some degree to iron and brass, by reason of either acid or alkaline impurities, and is, moreover, liable to contain more or less mud or silt.

General Summary of Accidents to Automatic Sprinklers.

Number of separate Sprinkler Systems	811
" " Sprinklers	514,071
Average number of Sprinklers in each System	633
Average time since Sprinklers were put in previous to Jan. 1, 1889	4.90 yrs.
Average water pressure, lbs. per square inch on lowest sprinklers	68.61
Maximum pressure, lbs. per square inch	180
Number of plants reporting leakage	375
Number of plants reporting damage	85
Total amount of damage ($2 to $2,000)	$10,375
Average damage per mill per year	$3.25
Average damage per plant per year	$2.56
No. plants reporting leaks from freezing	123
" " " " " belts, etc.	107
" " " " " blows, etc.	130
" " " " " water pressure	58
" " " " " corrosion, heat, etc.	108

The Syracuse Water Supply from Mayor Kirk's Standpoint.

Mayor KIRK, of Syracuse, N. Y., in closing the last meeting of the Common Council of that city for 1888, expressed himself substantially as follows on the disputed question of water supply: He commenced by stating that water is undoubtedly required in greater quantity, as with 200 miles of streets the city had only 35 miles of water mains. He then reviewed the actions of the Commission in recommending city ownership of the water-works, and said that for many years Syracuse had been paying $26,000 per annum for "a limited and unsatisfactory hydrant service," and that the three newest wards added to the city have not to-day either a single hydrant or a rod of pipe. Any adequate fire protection for the city would involve the annual payment of $50,000 on the present basis, and this payment capitalized at 3 per cent. would represent a bonded indebtedness of $1,700,000, while the works recommended by the Commission would cost only $3,000,000, including all necessary plant.

Mayor KIRK then recommends, as a first step towards a practical solution of present difficulties, the acquirement by the city of the property and rights of the private company which has operated in Syracuse for the past 40 years. He concludes by condemning the proposed additions on the gang-well system by the old company, and suggests the issue of $3,000,000 of water-bonds at 3 per cent. and the creation of a commission to construct works and obtain water. Legislative sanction should also be secured for the use of Skaneateles Lake as a source of supply. In a word, Mayor KIRK approves of the recommendations of the late commission and its engineer, and of speedy action upon these recommendations.

THE COLORADO COAL AND IRON CO. has commenced work upon the Bessemer and Huerfano irrigation canal near Pueblo, Col. This canal will take water from the Arkansas river 14 miles west of Pueblo and will empty into the Huerfano river 30 miles southwest. The ditch will be 22 ft. wide on the bottom, 7½ ft. deep and 26 ft. wide on top. It will irrigate 125,000 acres of the finest agricultural land in the Arkansas valley. Orman & Crook are the contractors.

THE CHESAPEAKE AND DELAWARE SHIP-CANAL project is being agitated again in Baltimore, and Mr. JAMES A. GARY, a wealthy and prominent Republican, is stated to be at the head of a movement proposing to divert some portion of the national surplus in this direction.

Concrete Construction at St. Augustine, Florida.

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The walls of the Ponce de Leon were in some cases as much as 10 ft. thick and in no case were the external walls less than 2 ft. thick. The moulds or formers used in construction were especially adapted to this work, but cannot be described without elaborate illustration. It is sufficient to say that the moulds were usually removed within 24 hours after placing the cement, and sometimes sooner than that. In many cases as much as 5 ft. in height of a wall was cast in one day. The work of placing the concrete was carried on under rigid discipline about as follows:—The concrete was dumped from the barrows and at once rammed in 6-in. layers with iron rammers 6 ins. sq.; these men were followed by others with 8-in. rammers, and the work was finished with broader rammers still; the final operation was to roughen the surface with a rake to prepare it for the reception of the next layer of concrete. The men thus went on around the walls of the building in regular procession, until a day's work was accomplished.

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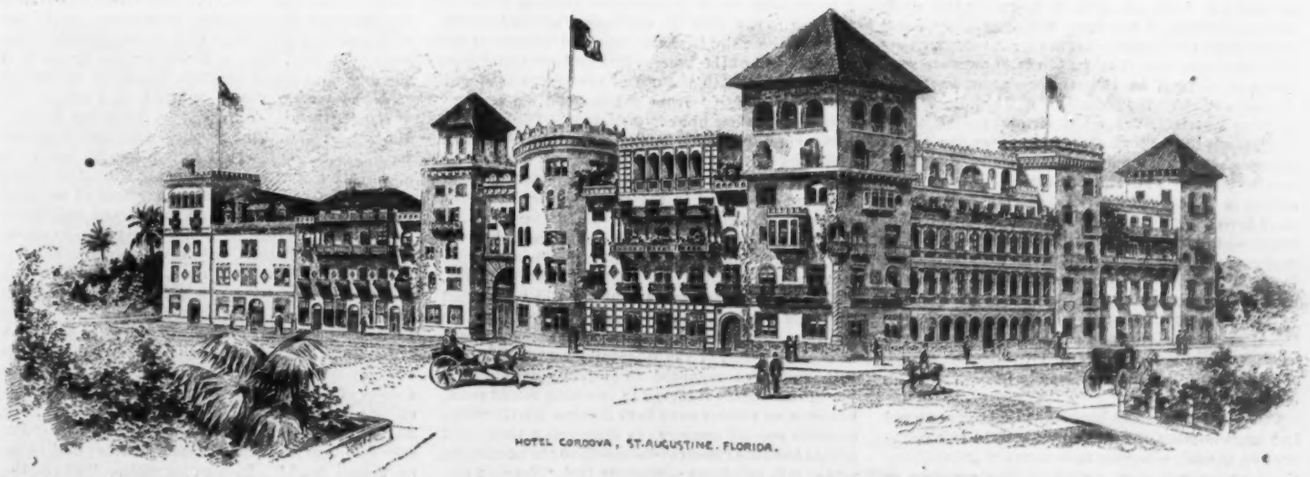
Proportion of Rainfall reaching the Sewers.

BY EMIL KUICHLING, M. AM. SOC. C. E.

The most important question which arises in the extension of a sewerage system whose function is also the removal of the surface drainage, as in Rochester, N. Y., is with regard to the amount of storm-water that will find its way into the sewers; and in this connection a brief review of the modes of solution adopted in other places may be of interest. The proportion of rainfall contemplated to be admitted into the sewers varies within wide limits, and depends largely upon the intensity and duration of the rainfall, the relative impermeability and slope of the surface, and the facility with which the storm-waters can be diverted into suitable natural channels, either directly from the roofs and street gutters, or indirectly by means of storm overflows from the sewers. The element of initial cost is also of vast significance in determining the limits, and, by being too narrowly considered, frequently leads to reductions of drainage capacity which must be supplemented a few years later by the construction of special relief conduits, whose expense is often much greater than the original amount saved, together with accrued interest.

Arguments to the effect that a municipality can better afford to pay the damages caused by occasional sewer-overflows than the interest on the additional expense involved by the provision of a more ample original capacity, are very common, but they never allude to the financial value of the annoyance, the sanitary dangers, or the depreciation of property which always follows where the sewerage is defective. To quote from a report of the engineer of the Brooklyn sewerage, dated Dec. 23, 1870: "Your engineer has been aware for several years of the importance of improving the sewerage system; and the frequent complaints of householders in certain localities of the city have caused the most careful investigation to be made from time to time. The flooding of basement and cellars depreciates the value of property and endangers the lives of those occupying the flooded dwellings. The offensiveness caused by sewage flooding drives away tenants. The damage done to property cannot be estimated by the soiled goods and injured walls, but must be measured by the permanent prejudice created against the locality. There are cases where the people of populous districts suffer patiently for want of proper sewerage and sanitary improvement, and yet the fear of taxation will lead them to oppose the carrying into effect of any important measure for relief; there are other property-holders who fear the result of any sanitary agitation, lest it should depreciate their property and prevent ready sales." The foregoing words are likewise applicable to many other cities than Brooklyn, and hence, before accepting the cogent arguments which appeal only to the economical instincts, a careful analysis of the problem with special reference to probable future conditions should be made, even though it be attended with many complications and difficulties.

In the absence of definite experiments of their own, our American engineers have generally based their practice of sewerage upon the results of certain gaugings of the storm discharge of a few sewers in London, which were made many years ago and while the subject was still in its infancy. For some unaccountable reason, the details of these gaugings have not been published, and in reading the meagre descriptions which are sometimes quoted, one is often at a loss to know whether the percentage of the rainfall so discharged refers to the maximum or to the average for the entire period. The familiar case of the Savoy Street sewer, which is alleged to have given, on June 20, 1857, from an unusually heavy rainfall for London of 1 in. in 1¼ hours, a maximum flow of 0.34 cu. ft. per acre per second, while the sewers of several adjacent and similar districts yielded only from one-fourth to one-seventh of this amount, is one of the few instances which are unambiguous in statement; but as some of these gaugings which were made by the London Commission of 1857, have been shown to be grossly inaccurate, the whole series ceases to have any scientific value. Two different gaugings by BAZALGETTE of the Savoy Street and Ratcliffe Highway sewers for rainfalls of 2.90 ins. in 36 hours and 25 hours respectively, refer specifically to the aggregate volume of rainfall discharged during said period, and not to the maximum rate of discharge at any instant, the percentages so computed being given at 64.5 and 52.0 respectively. From these and a few other results, the distinguished engineers, Messrs. BIDDER, HAWKESLEY, and BAZALGETTE, felt "warranted in concluding, as a rule of averages, that 0.25 inch of rainfall will not contribute more than 0.125 inch to the sewers, and that a fall of 0.40 inch will not yield more than 0.25 inch to the sewers." The two rainfalls mentioned are referred to as the "heaviest and most continued of the year 1857," and the two sewers are in the most densely populated portions of the city, the former "draining a locality strictly urban and of steep inclination," while the latter serves "a locality only moderately inclined." In the discussion of the main drainage of London at a meeting of



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the Institution of Civil Engineers in 1865, Col. WM. HAYWOOD, the Engineer to the Sewer Commissioners of that part of London called "The City," stated that in 1857, with a rainfall of 2.75 ins. in 36 hours, the London Bridge sewer discharged 74 per cent. of said fall in the same time, and in 1858, with a rainfall of 0.24 ins. in 1.5 hours, the same sewer discharged 74 per cent. of the fall; also that in June, 1858, "the Irongate sewer, which drains an area entirely paved and built over, discharged as much as 94.5 per cent. of a rainstorm of 0.54 in. in 5 hours," while two months later, the same sewer "discharged only 78 per cent. of a rainfall of 0.48 in. in 1.67 hours." Presumably these figures are the maximum percentages observed on those occasions, although nothing further than their extraordinary magnitude warrants such a conclusion, if the rainfall happened to be uniform in intensity. None of the reports, however, give any clue to the character of the rainfall, the manner in which it was observed, or the location of the gauge, and hence the anomalies of measured percentage of discharge may be easily explained. Another familiar English authority on the subject is Mr. JOHN ROE, who was for many years surveyor of the Holborn and Finsbury sewers, and who states that during the continuance of a rainfall of 1.0 in. per hour, from 41 to 54 per cent. of the precipitation will reach the sewers according to the amount of garden land or lawn upon the drainage area.

Upon the foregoing indefinite data principally, which may be found quoted more or less extensively in nearly every treatise on sewerage, and in most of the elaborate reports, engineers have hitherto been content to rely; and it has thus come to be in some measure traditional that about 50 per cent. of the rainfall will run off from urban surface during the progress of the storm, while the remainder may follow at leisure. The greatest depth of rain for which provision should be made in planning sewers of American cities has likewise been commonly taken at 1 in. in an hour, "as its frequency, when compared with such falls as 2 to 3 ins. in the same time, renders its consideration a more practical question; and the possibility of this rate of fall occurring for shorter intervals of time is so apparent from past observation on the sea-board, and in the interior of the country, that we may regard it as a very proper maximum. It has been adopted as such in England, and so far as we can learn, also in this country." ("Sewers and Drains for Populous Districts," by J. W. ADAMS, 1880.) This view still continues to prevail extensively, and but few engineers have ventured to step outside of the beaten path. On this basis, also, the sewerage systems of Brooklyn, N. Y., and Providence, R. I., which have long enjoyed the distinction of being the best works of the kind in the United States, have been designed. It was considered that, inasmuch as the English gaugings indicated that only from 50 to 75 per cent. of the volume of rainfall ever entered the sewers at all, the provision of a capacity for discharging a depth of ½ in. of rain over the whole area uniformly in one hour was very liberal, and would afford an ample margin for the contingencies of future growth. The fact was, however, soon established that, as these cities grew in population and in the number of buildings and improved streets, the main sewers proved to be inadequate to carry off the storm-water due to the heavy showers of comparatively short duration; and to remedy the evils resulting from deluged cellars in the flooded districts, special storm-sewers have been constructed, and additional ones are contemplated in both cities. In Providence, an attempt was made to restrict the amount of water admitted into the sewers, by throttling the street inlets in such manner as to compel a portion of the rainfall to escape by flow through the gutters; but while the sewers may thus be somewhat relieved, the annoyance and damage caused by flooded streets is substituted, and may ultimately become an intolerable nuisance.

The same experiences have likewise been observed in a large number of other cities, both in this country and abroad, wherever rainstorms of great intensity for relatively short periods of time are more or less frequent, and where the principles above set forth have been adopted in computing the size of main sewers unprovided with storm-outlets. It is conceded that in the majority of these cases, notably in the two cities named above, no fault can be found with the execution of the sewerage works, and hence the failure must be attributed to the assumptions with respect to rainfall upon which the calculations are based. The writer was long since impressed with the fact that during heavy showers the volume of water discharged at the mouths of several large outlet-sewers in Rochester appeared to increase and diminish directly with the intensity of the rain at different stages, but that a certain length of time was required in each case, after the termination of a brief and heavy down-pour, before the corresponding flood showed itself at the out-fall; these floods, moreover, seemed to last about as long as the said showers themselves, and the conclusion was therefore reached that there must be some definite relation between these fluctuations of discharge and the intensity of the rain, also between the magnitude of the drainage area and the time required for the floods to appear and subside. The observations referred to were made casually, during showers, giving about one-half inch depth of fall in from 20 to 30 minutes, and the flood discharge would begin about 10 minutes after the commencement of the rain, or of the component showers; in like manner the maximum flow would quickly diminish, leaving only a very moderate after-flow to continue for some time after the rain had ceased. Now, since the total proportion of the rainfall which is carried off by the sewers is of little consequence, whereas the absolute maximum flow during any short period of time is manifestly the controlling factor in estimating the efficiency of a sewer, and since this maximum appears to be governed by the rate of the rainfall during such short periods, therefore the error made in the assumptions mentioned above must be due to the use of average rates of rainfall for an unduly long period of time, and the neglect of the rates for such short periods, within which the surface drainage waters from all portions of the area may be concentrated at the out fall. This error becomes still more apparent when we reflect that for a uniform rate of precipitation, the concentrated discharge from a given surface will become a maximum for the condition, that the duration of such rate is equal to the time required for the water which falls upon the most distant points to reach the place of observation, or in other words, that the entire area is contributing to said discharges; also from the fact that the heavy rainfalls in our latitudes rarely ever have uniform intensities for so long a period as one hour, and that few densely populated drainage areas contained within the municipal limits are so large as to require more than from 15 to 40 minutes for the full concentration of the storm-waters at some point of discharge. The conclusion is accordingly irresistible that the rates of rainfall adopted in computing the dimensions of a main sewer must correspond to the time required for the concentration of the drainage waters from the whole tributary area when small, or from so much thereof as will produce an absolute maximum discharge when the area is very large.

In justification of the prevalent practice, however, it is fair to say that the customary methods of observing the rainfall have hitherto prevented the development of the process just indicated, and have forced engineers to the use of average rates of precipitation deduced from periods of time scarcely ever less than one hour in duration. Thus, the extensive and frequently quoted collection of rainfall statistics relating to Providence, R. I., which were made during 40 years, by Dr. A. CASWELL, of that city, and published in the excellent report on the sewerage of Providence, by J. H. SHEDD, C. E., in 1874, contain in the tables giving the record of 326 storms whose duration was carefully observed only three cases where the rain lasted less than one hour, and in those instances the intensity did not exceed one inch per hour. The records were alleged to cover every appreciable rainfall which had occurred in said city during the interval between 1834 and 1874, and were regarded as perfectly reliable. A few of the storms observed in this long period were, however, so violent as to have induced Dr. CASWELL to make special memoranda concerning them, and of this list only three entries specified the maximum rate of fall, as follows:—Sept. 28, 1862, "Nearly 2 ins. of rain fell in the course of one hour;" Aug. 16, 1863, "Very heavy thunder-shower, 1.42 ins. of rain falling in about 20 minutes; June 17, 1870, storm lasting 5 hours and giving "3.15 ins., nearly all of which fell between 12 M. and 1 P. M." Now, from these data the following condensed tables, showing the relative frequency of rainfalls of different intensity per hour at Providence were constructed in 1874, and have since been widely copied by many distinguished writers in proof that great intensities of rainfall are exceedingly rare occurrences in our climate:

Rate of Rainfall in inches per hour.	I. No. of Storms during 26 years from 1834 to 1860	II. No. of Storms during 14 years from 1860 to 1874.	III. No. of Storms during 40 years from 1834 to 1874.
0.25, or a little less	131	98	229
0.33 " "	18	9	27
0.40 " "	9	2	11
0.50 " "	7	10	17
0.60 to 0.62	8	5	13
0.67 to 0.70	3	3	6
0.75 to 0.80	3	2	5
0.87 to 0.90	4	1	5
1.00 to 1.12	1	2	3
1.30 to 1.40	0	2	2
1.62 to 1.88	1	2	3
2.00 to 3.15	0	3	3
Totals	185	139	32

The inferences that have been drawn from the foregoing table, even long after it was discovered that some of the main sewers in Brooklyn and Providence had repeatedly proved to be incapable of removing the storm drainage, are as follows: (1) that out of 324 large rainfalls in 40 consecutive years, only 3 gave rates of 2 ins. or more per hour, 6 gave rates of more than 1.5 ins. per hour, and 11 gave rates of 1.0 inch or more per hour; and (2) that therefore a rainfall of 2 ins. or more per hour can reasonably be expected to occur only once in 13 years, while one of more than 1.5 ins. per hour may happen once in about 7 years, and one of 1.0 inch or more per hour about once every 4 years. Such inferences are, however, entirely unwarranted by the records derived from automatic rain gauges, which indicate that heavy rates for short periods of time are very common occurrences; and it is needless to say that even casual observation of the rainfall in this vicinity prevents the application of the aforesaid inferences to intelligent sewerage work for this city. To give reasonable assurance that special storm-sewers will not be required in a district within a few years after the development of the suburban area has progressed, accordingly involves the adoption of a much higher rate of precipitation than one inch per hour when the time required for the concentration of the surface-discharge is much less than one hour, as is generally the case.

The famous hydrological studies of the basin of the river Seine, by Belgrand, caused the Parisian engineers to adopt a maximum rainfall of 1.77 ins. in one hour as a governing factor in proportioning the modern sewerage works of the French capital. For the outlet sewers of large districts, it is assumed that about one-third of this depth is collected or concentrated during the progress of the rain and flows off rapidly, while the remainder is retarded in its flow, and is lost by evaporation and absorption. To compare the foregoing maximum of 1.77 ins. with a similar maximum that might be selected for some other city, such as Rochester, on the basis of the average annual rainfall, it may be mentioned that the average yearly rainfall of Paris is only about 23 inches, while that of Rochester is about 33.5 inches; so that the proportionate maximum rate for the latter city would be 2.60 ins. per hour. In anticipation of comment, however, the writer would remark that the available observations of the local rainfall do not give so high an average, and that a rate of such magnitude would apply only to an extremely small district, or in other words would prevail for only a very short time, as fully pointed out in the preceding paper. In referring to the Parisian practice, in an excellent article in the "Annales des Ponts et Chaussées" for February, 1888, D. E. Mayer, of the French Engineer Corps, advises the adoption of Belgrand's estimate, as given above, for like conditions of rainfall, climate, and proportional amount of impervious surface, in other large cities, "deducting, however, in the computation of the tributary drainage area, all gardens and other cultivated or vacant land." In smaller cities, "where the density of population is less, the proportion of such garden and other open land is greater than in the larger towns, and hence a much larger proportion of the rainfall would be lost before reaching the sewers, while the ordinary discharge per acre also

diminishes with said density." It is therefore probable that the proportional discharge adopted in Paris may likewise be applicable in minor municipalities where it becomes necessary to remove the surface drainage.

(TO BE CONTINUED.)

The Practical Calculation of the Heads, Diameters, and Discharges of Long Pipes.

BY E. SHERMAN GOULD.

(*Continued from Page* 188.)

Let us, finally, suppose a system in which the 48 in. pipe is tapped every 500 ft. by a 24-in. pipe, 500 ft. long, laid as before with a grade of 4 ft. in 500.

Assuming a height of 9 ft. for the piezometric column h nearest the free end of the pipe, we have

$$12.56\sqrt{\frac{4\times 9}{0.31}}+3.14\sqrt{\frac{2\times 5}{0.32}}=12.56\sqrt{\frac{4\,(h'-9)}{0.31}}$$

Since the denominators under the radicals are so nearly equal, we may cancel them, and, making other simplifications, write:

$$8\sqrt{9}+\sqrt{10}=8\sqrt{h'-9}$$

whence:

$$h'=20.5$$

We have next:

$$8\sqrt{11.5}+\sqrt{2\times 4.5}=8\sqrt{h''-20.5}$$

whence:

$$h''=35.5$$

Again:

$$8\sqrt{15}+\sqrt{2\times 11}=8\sqrt{h'''-35.5}.$$

whence:

$$h'''=55.38.$$

Comparing this last value with the known height 50, we have by proportion the correct values:

$$h=8.13.$$
$$h'=18.51$$
$$h''=32.05$$

Calculating the various discharges under these piezometric heads, calling those through the different sections of 48-in. pipe commencing at the lower end, Q, Q_1, Q_2, Q_3, and those through the corresponding 24-in. branches, q, q_1, q_2, q_3, we have:

$$Q=12.56\sqrt{\frac{4\times 8.13}{0.31}}=128.61$$

$$q=3.14\sqrt{\frac{2\times 4.13}{0.32}}=15.97$$

$$Q_1=12.56\sqrt{\frac{4\times 10.38}{0.31}}=145.32$$

$$q_1=3.14\sqrt{\frac{2\times 6.38}{0.32}}=19.81$$

$$Q_2=12.56\sqrt{\frac{4\times 13.54}{0.31}}=166.04$$

$$q_2=3.14\sqrt{\frac{2\times 9.54}{0.32}}=24.24$$

$$Q_3=12.56\sqrt{\frac{4\times 17.95}{0.31}}=191.16$$

These are very close approximations, quite close enough in ordinary practice, but the slight discrepancies show that the proportion by which we deduced the values of h, h_1, and h'' does not seem to hold, when there are a number of branches, so nearly as when there is only one. The correct value of h is probably about 8.20 instead of 8.13. In practice, the circumstances of the case would indicate whether it was necessary to try another approximation.

It is worthy of note that the total discharge in this case is practically equal to that obtained with a single branch situated 500 ft. from the reservoir. In general it will be found, as in these two cases, that when a main is tapped at a certain point by a single branch, the total discharge is only slightly increased by the introduction of a series of branches of the same dimensions placed below the first junction. The position of the first branch, however, has, as the above examples show, a very great influence both on the volume of discharge and the form of the hydraulic grade line. This latter feature merits careful attention.

As a further study of a system of pipes to deliver water, let us suppose a town divided by intersecting streets into blocks 1,000 ft. sq., as shown in Fig. 9. We will suppose that the proposed water supply requires a total volume of 3 cu. ft. per second, equal to say 800,000 U. S. galls. in 10 hours.

The water is to be introduced by a central main A B C, and delivered east and west by the side mains D D', E E', F F', G G', and H H'. At the extremities of these mains, the water is to be delivered at the elevations above datum indicated by the figures placed in brackets. The side mains D D' and E E' are to deliver each, east and west, ¼ cu. ft. per second, which quantity we will suppose is to be carried through the whole length of the pipe, and delivered at its extremity, without regard to the quantities

Fig. 9.

drawn off *en route* by the service pipes and smaller north and south mains. This will secure good pressure on the hydrants in case of fires. The total delivery of the above two side mains will therefore be 1 cu. ft. per second. The remaining three side mains, F F', G G', and H H', are to deliver, similarly, ¼ cu. ft. per second, making 2 cu. ft. for the three.

These being the data, we will suppose the problem to be the determining of the respective diameters of the pipes, and the height to which the water must be raised in a supply reservoir, or standpipe, situated somewhere to the north of the town.

The problem thus stated is indeterminate and admits of an indefinite number of solutions, for we may either use large pipes and low elevation or small pipes and a high elevation. Practically, however, there are limitations to this; for in the first place we shall naturally be restricted as to the height to which it would be possible or advisable to raise the water, and secondly, experience shows that we should confine ourselves within certain limits as regards the velocity of the water in the pipes.

Generally speaking, these velocities should not exceed such as would be produced by a fall of from 4 to 8 ft. per thousand, according to the size of the pipe; the greater fall belonging to the smaller diameter.

Before commencing the calculations, it will be well to establish certain additional formulæ, derived from (4), which are frequently of considerable utility.

When the length and diameter are constant:

$$\frac{Q^2}{Q^1}=\frac{H\,C}{H\,C}$$

When the head and diameter are constant:

$$\frac{Q^2}{Q^1}=\frac{L\,C}{L'\,C}$$

When the head and length are constant:

$$\frac{Q^2}{Q^1}=\frac{D^5\,C}{D^5\,C}$$

$$\frac{D^5}{D^5}=\frac{Q^2\,C}{Q^2\,C}.$$

When the heads and discharge are constant:

$$\frac{D^5}{D_1^5}=\frac{L'\,C}{L\,C}$$

When the lengths and discharges are constant:

$$\frac{D^5}{D^5}=\frac{H\,C}{H'\,C}$$

These relations indicate that, other things being equal, the squares of the discharges vary directly as the heads and the fifth powers of the diameters, and inversely as the length; and that, other things being equal, the fifth powers of the diameters vary directly as the squares of the discharges and the lengths, and inversely as the heads.

As these relations are generally used for approximations, the coefficients may be dropped, and the equations written in this form:

$$Q=\sqrt{\frac{Q^2\times H}{H}} \qquad (6)$$

$$Q=\sqrt{\frac{Q^2\times L}{L'}} \qquad (7)$$

$$Q=\sqrt{\frac{Q^2\times D^5}{D^5}} \qquad (8)$$

$$D=\sqrt[5]{\frac{D^5\times Q^2}{Q^2}} \qquad (9)$$

$$D=\sqrt[5]{\frac{D^5\times L}{L}} \qquad (10)$$

$$D=\sqrt[5]{\frac{D^5\times H}{H'}} \qquad (11)$$

Other combinations can be made from these relations. Thus:

$$D=\sqrt[5]{\frac{D^5\times H\times Q^2}{H'\times Q^2}} \qquad (12)$$

Commencing now with the west side of the main H H', we have ¼ cu. ft. to be delivered at an elevation of (160) above datum. As the pipe will be a comparatively small one, we will assume a grade of $\frac{5}{1000}$, which will give a rise of 16 ft. between the extremity and the main junction, and requires an elevation of piezometric head, at this junction, of (176), as shown in the figure.

To obtain the proper diameter of pipe for this grade and discharge, we have, using (4), and assuming $C=0.00076$ as a probable value:

$$D^5=\frac{(\frac{1}{4})^2\times 1{,}000\times 0.00076}{8\times 0.61}$$

whence $D^5=0.017304$

and $D=0.444$.

Or, for the next highest even inch:

$$D=6 \text{ inches.}$$

As regards the diameter of the pipe on the east side, since the length and discharge are the same as for the west side, and only the heads vary, being respectively 16 and 36 ft., it can be obtained by means of (11).

Thus

$$D'=\sqrt[5]{\frac{0.017304\times 16}{36}}$$

$$D'=0.3777$$

or, for next highest even inch:

$$D'=5 \text{ inches.}$$

The above head of 18 ft. per thousand produces a velocity of flow in a 5 in. pipe of a little over 3 ft. per second, which is somewhat greater than it should be. If the limit of velocity is overstepped to any considerable degree in a system of pipes such as we are considering, it is the best practice to use a larger pipe and checks its flow down to the desired delivery by means of a gate or stop cock placed near its upper end, the effect of which will be to diminish the head. In the present instance, the excess of velocity is not sufficient to render this precaution necessary.

The elevations are such that the above diameters of 6 and 5 ins. are also proper for the side mains G G', F F'.

It is now necessary to calculate the diameter of the central main, from B to C. This main might be divided into two parts, that between F F' and G G', and that between G G' and H H', but we will calculate it on the supposition of a uniform diameter, capable of delivering the entire volume of ¾ cu. ft. per second as far as H H'.

Assuming a probable value of $C=0.00006$, we have from (4):

$$D^5=\frac{\frac{16}{9}\times 1.32}{6.1}$$

whence

$$D^5=0.3847$$

and

$$D=0.826=10 \text{ ins.}$$

Taking now the mains E E' and D D', and beginning on the west side, assuming as before a grade of 8 ft. per 1,000, we find the length and head equal to those of F F' etc., the only difference being the quantity it is desired to deliver, which is now ¼ cu.

ERRATA.—In the last issue, March 9th, the results of the two equations at the top of the 3d column of page 212 are incorrectly printed. They should be respectively 149.5 instead of 42.3, and 42.3 instead of 191.8.

ft as against ½ in FF. The relation (9) is therefore applicable, and we have:

$$D = \sqrt[5]{0.017304 \times \frac{4}{16}}$$

whence

$$D^5 = 0.0067335$$

and

$$D = 0.336$$

or, say,

$$D = 5 \text{ ins.}$$

The mains on the east side are determined as before:

$$D' = \sqrt[5]{0.0067335 \times \frac{16}{31}}$$

$$D' = 0.346$$

This is not quite 4¼ ins., but to ensure the desired delivery, it will be best to take the next highest even inch, and call it 5 ins.

As regards the central main from A to B, we find two grades, the upper one $\frac{5}{1000}$, and the lower $\frac{3}{1000}$. The lower section must deliver, under a grade of $\frac{3}{1000}$, all the water required for FF, GG', and HH', aggregating 2 cu. ft. per second. Using (4), and taking 0.00006 as a probable value of C, we have:

$$D^5 = \frac{4 \times 0.06}{6.1}$$

whence

$$D^5 = 0.4328$$

and

$$D = 0.846$$

This is very nearly 10¼ ins., and a 10-in. pipe would answer, though 12 ins. would be better.

The upper section must deliver 2.5 cu. ft. per second, under a grade of $\frac{5}{1000}$. Taking the same probable value of C, we have:

$$D^5 = \frac{6.25 \times 0.06}{3.05}$$

Whence

$$D = 1.287$$

which we can take as either 15 or 16 ins.

This diameter might have been obtained from that of the lower section, by means of (12). Thus

$$D'^5 = 0.4328 \times \frac{10}{5} \times \frac{6.25}{4}$$

$$D' = 1.287$$

This last method might have been used throughout, but (4) is about as short and convenient, frequently more so.

The diameters being thus determined, the quantities should be verified by (3). They will be found somewhat in excess of those proposed, owing to the general increase of the diameters.

As regards the height to which the water must be raised, the data show that 3 cu. ft. per second must be raised to a sufficient height to reach DD' at an elevation of (201) above datum. If we adopt a grade of $\frac{5}{1000}$, the proper diameter of the pipe would be:

$$D^5 = \frac{9 \times 0.65}{2.44}$$

$$D = 1.32$$

or,

$$D = 16 \text{ ins.}$$

If, instead of pumping, the water were collected in a reservoir by damming up the natural flow of some stream, and the dam were of necessity situated at an elevation so great that a dangerous velocity is apprehended, it would be necessary to first receive the water into a distributing reservoir situated at a lower level, or else, as a less advantageous expedient, to reduce the pressure by gates, properly located for the purpose.

It should be well understood that all the above assumed data, particularly such as relate to heads, are subjected to considerable variation in actual practice. All the calculations have been based, of necessity, upon the hypothesis that the exact allotted volume per second is being simultaneously drawn from the whole system. This would rarely be the case; for at any given second, the draught would be liable to fluctuate greatly from the average. Indeed, these calculations should only be regarded as fixing, with some degree of approximation, the proper relative diameters to secure proper relative discharges and pressures at the different points supplied.

The remaining north and south pipes should be calculated in the same way. Thus, those below FF on the west side discharge 1-6 cubic ft. with a grade of $\frac{3}{1000}$. This would require a 4-in. pipe. The draught from these would somewhat lower the piezometric heads at their junctions with the side mains. In a fine calculation, these reductions should be worked out, as was done in the previous example of branch pipes: in general, however, and in cases where the whole supply is supposed to be carried through to the extremity of the mains, as was done in the present instance, and where a liberal interpretation has been given to the calculation of diameters, this is not indispensable. At the same time, it should be a guiding principle of waterworks engineering, that a few hours spent in the office, in what may sometimes be considered an over-refinement of calculation, is by no means a waste of time, and frequently enables one to make advantageous and economical modifications in a project of distribution.

It may here be noted that (12) admits of being put into a very convenient form for rapid approximations. To do this, we have only to calculate the discharge of a pipe 1 ft. in diameter, with a fall of 1 ft. per thousand, and to refer all other discharges with the fall per thousand feet to it, in order to obtain the corresponding diameter. The quantity discharged by the above pipe is 0.961 cu. ft. per second, and the square of the same is 0.924. Equation (12) may then be written:

$$D = \sqrt[5]{\frac{Q^2}{H} \times 1.08}$$

or, very nearly:

$$D = \sqrt[5]{\frac{Q^2}{H}} \qquad (13)$$

We have also, very nearly:

$$Q = \sqrt{D^5 \times H} \qquad (14)$$

These last formulæ, it will be perceived, are based on the fact that, given a certain probable degree of roughness, a pipe 1 ft. in diameter, with a fall of 1 ft. in a thousand, will deliver 1 cu. ft. of water per second. If we desire to apply them to smooth, clean pipes, we have only to *halve the coefficient* for a 12-in. pipe, which will be equivalent to writing the above formulæ thus:

$$D = \sqrt[5]{\frac{Q^2}{2H}} \qquad (15)$$

$$Q = \sqrt{D^5 \times 2H} \qquad (16)$$

These formulæ will be found of very great utility in aiding to arrive quickly at approximate results. They can be advantageously used in sketching out a network of pipes such as we have just been considering. To increase their utility, the following table of fifth powers has been calculated. This table indicates, by inspection, the diameters in inches, corresponding to the fifth roots of the right-hand side of the equations, expressed in feet.

Diameters in inches.	*5th powers in feet*	*Diameters in inches.*	*5th powers in feet.*
3	0.00097	22	20.72
4	0.00415	24	32.40
5	0.01250	26	47.75
6	0.03125	28	69.17
8	0.1317	30	97.66
10	0.4019	32	134.9
12	1.0000	34	182.6
14	2.1615	36	243.0
16	4.14	40	411.5
18	7.395	42	525.2
20	12.86	48	1021.0

All the diameters which have been already calculated can be obtained very nearly by the use of (13). Relations (13) and (14) might also have been used in some of the previous examples, but scarcely with advantage.

(TO BE CONTINUED.)

JOHN ERICSSON.

(With Portrait.)

JOHN ERICSSON, whose lamented death on the 8th inst. ended the earthly career of one who was easily the greatest among living engineers, was born in Wermland, Sweden, Aug. 1, 1803, and was consequently, at the time of his death, well advanced in his 86th year. GEORGE STEPHENSON, destined to be, 26 years later, his successful rival in the great *Rocket* competition, was then 22 years of age, and had been for over 15 years a colliery hand engaged in the most menial work, having yet 11 years to live before his first locomotive (1814) and his invention of the safety lamp (1815) were to reveal the genius which was to make him immortal. TREVETHICK and OLIVER EVANS, independently and almost simultaneously, had invented the high-pressure steam engine two or three years before, and TREVETHICK was then building the first real locomotive which ever ran (1804) to be matched in the same year by EVANS' "Oruktor Amphibolis," a much less practical, but still practical, working locomotive. WATT had then just retired from business after building a few thousand horse power of steam engines, chiefly for pumping out mines. Practically, however, the age of steam in all its forms was then undreamt of; and one man's life, which has ended this week—almost the last of those who can be said in any sense to have played a great part in bringing it about—has covered all of it.

We have spoken elsewhere of the broader features of ERICSSON's life, and confine ourselves here to as brief as possible a notice of the main facts of his busy and useful life. His father, OLAF ERICSSON, was a miner in humble circumstances, but his mother was a woman of excellent family and superior education, whose father had lost a fortune in unlucky investments, so that he had a fairly good early start, as also his brother NILS, who was likewise endowed with decided engineering genius, and who served prominently in both the Swedish Army and Navy, was director of Swedish railways, built many great public works, and was finally ennobled.

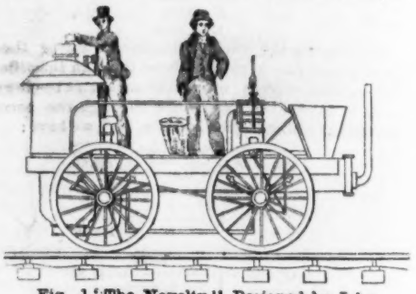


Fig. 1 "The Novelty." Designed by John Ericsson, 1829.
Weight, 2 tons, 1 cwt.

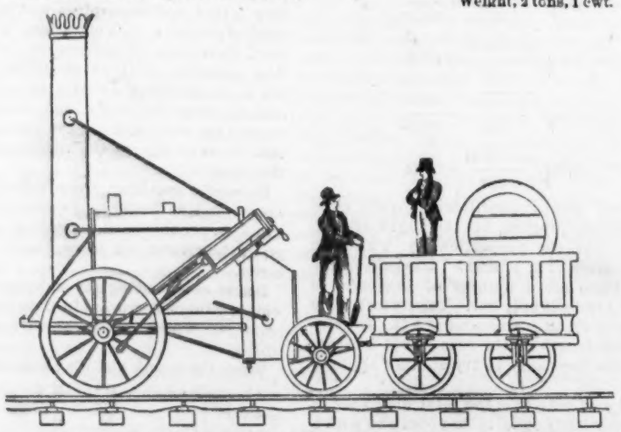


Fig. 2 The "Rocket." Designed by George Stephenson, 1829.
Weight of engine, 4 tons, 5 cwt.; tender, 3 tons, 4 cwt.; total, 7 tons, 9 cwt.

JOHN ERICSSON at the age of 11 was appointed a cadet of engineers, and at the age of 13 so pleased the engineer in charge that he was made a "leveler" on the great ship-canal between the Baltic and the North Sea; perhaps the youngest leveler on record. At the age of 17 (1820) he entered the Swedish Army and was employed on government surveys. At the age of 23 (1826) he first visited England with a view to introducing a "flame engine" which he had invented—the germ of his caloric

engine. He then resigned his commission (but was first promoted to Captain), and invention after invention followed. They included a file-cutting device, an instrument for taking soundings (still in use), a hydrostatic weighing machine, an apparatus for making salt from brine, a pumping-engine, a rotary steam-engine, and a famous system of artificial draught for steam boilers, dispensing with huge smokestacks, and economizing fuel. To the steamship *Victory*, in 1828, he applied the principle of condensing steam and returning the water to the boiler; and four years later he gave to the *Corsair* the centrifugal fan-blower now generally used in American steam vessels.

In 1829 came the famous offer from the Liverpool & Manchester Railway of a reward of £500 for the best locomotive engine, which led to ERICSSON'S first really grand achievement. The offer was published April 25 for a trial to take place Oct. 1, thus allowing only 5 months in which to design and build the required engine. STEPHENSON was Chief Engineer, and had already for 15 years been building locomotives, and was moreover 43 years old against ERICSSON'S 26. He had every advantage of position and probability in his favor; but nothing daunted, ERICSSON designed and hurried to completion, all in seven weeks, the engine which he well named the "Novelty." It proved to be the "Rocket's" only real competitor, and was for a time thought likely to win the prize. We show in the accompanying engraving (Figs. 1 and 2) the Novelty and the Rocket to the same scale, reproduced photographically from a copper plate in a contemporary account, which we have in our library. The London *Times* of Oct. 8, 1829, said that in speed it "far excelled" all competitors; that "it was the lightest and most elegant carriage on the road yesterday, and the velocity with which it moved surprised and amazed every beholder. It shot along the line at the amazing rate of 30 miles an hour." "In locomotive engineering," wrote JOHN BOURNE, nearly half a century later, "nothing more original or more elegant has been produced than the Novelty."

Although this was not one of Capt. ERICSSON'S great practical successes, it was perhaps one of those which shed most honor on his genius, and it is therefore well to narrate more in detail the circumstances of this fateful contest. The conditions of competition required that the engine should in no case weigh more than 6 tons. It was to haul 15 tons, if weighing 5 tons or over, or three times its own weight if weighing less, and it was stated that "machines of less weight would be preferred," if they could fulfil this test.

The competitors were:

		tons	cwt.
Mr. R. STEPHENSON	"Rocket"	4	5
Messrs. BRAITHWAITE & ERICSSON	"Novelty"	3	1
Mr. HACKWORTH	"Sans Pareil"	4	15½
Mr. BRANDRETH (horse machine)	"Cycloped"	3	0
Mr. BURSTALL	"Perseverance"	2	17

The Rocket was first tested, on Oct. 6, 1829, hauling 12¾ tons for 12 miles at 13½ miles per hour. The Novelty was then tried informally, making 24 miles per hour without load. On the next day the bellows of the Novelty broke down. On the next day the Rocket was again tried, hauling three times its own weight, tender being counted in with train—obviously a very unfair condition, as we can now see, in comparing an engine with tender with one like the Novelty having none. Counting engine and tender together, the Rocket weighed 7 tons, 9 cwt., and hauled 29 tons, 11 cwt., or but little more than its own weight. It then made 20 successive trips at speed over a 1¼ mile course, making 13.4 miles per hour in the first series of 10 tests, and 14.2 in the last series. An interesting fact was that there was a very notable loss of speed when the engine was backing and pushing the train, as compared with pulling.

The other engines not being ready, the tests were postponed to Oct. 10. Discussion as to the proper comparative load naturally arose, but it was finally decided "that since the Rocket weighed 85 cwt. and carried 191 cwt. of useful weight, then the Novelty, weighing 61 cwt. (deducting weight of water and tank), should by the rule of three take 137 cwt. of useful weight, leaving each engine to carry their fuel and water in their own particular way." Hence the Novelty, weighing 77.5 cwt. with fuel and water, was loaded with 137 cwt. of cars, or 1.77 times its own weight, whereas the Rocket, weighing 149 cwt., or about twice as much, had hauled only 190 cwt., or 1.28 times its own weight. Had the Novelty been loaded only with 99 cwt., the result might possibly have been different. She hauled this load once over the course at "upwards of 15 miles per hour," a much better relative performance than the Rocket's, but in returning "the pipe from the forcing pump burst, and put an end to the trial." Later on the same day this break was repaired, and "the engine made several trips with a coach (in which were many scientific gentlemen) at the rate of 24 to 28 miles per hour."

On Tuesday, Oct. 13, the Sans Pareil was tried, engine and tender weighing 16 cwt. and hauling 220 cwt., or 1.38 times its own weight. The water gave out on the eighth trip, but it hauled its load for that distance at 13¾ miles per hour. Oct. 14, the Novelty was again tried, but after running 3 miles at 10¾ miles per hour "the pipe which conveys the heated air from the furnace through the horizontal boiler collapsed," and the steam put out the fire.

The Novelty was then withdrawn, and STEPHENSON was adjudged a well-earned victory. After the judgment, the Rocket was "detached from all encumbrance (apparently from tender as well as from cars) and in making two trips it moved at the astonishing rate of 35 miles an hour." But, while it is apparent that the mechanical construction of the Rocket was more perfect, as it naturally should have been from STEPHENSON'S already large experience, yet the Novelty's performance was almost equally creditable, apart from these mechanical defects; and that the directors thought so, too, is evident from the fact that the very next year they ordered two more of the Ericsson engines, one of which, the "William the Fourth" was of 20 H. P. (cylinders 12 x 14 ins.) and was "perfectly capable of performing all the work it has been contracted to perform—namely, drawing the enormous load of 40 tons at the rate of 15 miles an hour." This engine, by the way, had loose wheels on the tender, and came to grief shortly after in consequence. All this we find set forth in the *Mechanics' Magazine*, of London, for Sept 25, 1830, where the next following article, we may add, is an article headed "The First Projector of Steam Travelling," clearly giving that credit to OLIVER EVANS, and we think with justice.

Nothing discouraged by this grievous disappointment, ERICSSON kept on inventing. In that very same year, 1829, he constructed a successful steam fire-engine, which was used to put out a fire, and two others were immediately built. In 1830 he introduced in the locomotives King William and Adelaide, the link motion for reversing steam-engines, thus anticipating STEPHENSON by nearly three years, although probably somewhat crudely. We have been unable to find drawings showing the precise form of his link motion. In 1834 he superheated steam in an engine on the Regent's Canal Basin.

His famous caloric engine, the first of his undisputedly great and novel achievements, was produced in 1833. The scientific world hailed it with astonishment. LARDNER, URE, FARADAY, and others gave special attention to it. The high temperature evolved prevented the first machine from becoming practical, while twenty years later, in 1853, a voyage of the caloric ship *Ericsson*, a vessel of 2,000 tons, 200 ft. long, from New York to Washington and back, showed that, though economical in fuel, the new heated-air motor could not produce speed enough at sea for commercial purposes, nor compete on any large scale with steam. Still it has been applied successfully to thousands of small engines for minor useful purposes—pumping, printing, hoisting, grinding, telegraph instruments, sewing machines, and so on.

While ERICSSON was developing this engine, however, he was also thinking out the very greatest of his inventions, the screw-propeller. In the idea he was clearly not the first, for Col. JOHN STEVENS, in 1804, built and operated in New York harbor, a small twin-screw steamboat, which was undoubtedly the first in the world, and which is now in the Stevens Institute, Hoboken, where it will be seen that the propellers bear a singularly close resemblance to the modern form. In 1806, Col STEVENS built another larger boat and went to Albany with it a few days after the *Clermont*. But nothing came of these tests, and by an unusual agreement in such matters, ERICSSON is given the honor of inventing the propeller in practical form the world over.

In 1837, he built a tug, having 2 propellers of 5¼ ft. diameter, invited the British Admiralty to inspect it, and towed their barge at a rapid rate; but their lordships solemnly concluded that, as the motive power was in the stern, the novel craft would not steer. This sapient decision drove him to this country, which has ever since been his home; and in 1841 he began to build the *Princeton*, the first naval vessel that ever carried her machinery under the water-line, out of the reach of hostile shot. This vessel dictated reconstruction to the fleets of the world. The *Princeton* included as other inventions of ERICSSON, a direct-acting steam-engine of unusual compactness; a telescope smokestack, in place of the tall ordinary pipe; a centrifugal blower in the hold: a gun-carriage with machinery for taking up the recoil, the self-acting look allowing the gun to be fired accurately. The London *Mechanics' Magazine* well said: "The undivided honors of having built the first practical screw-steamer, the first screw war-ship, the first cupola [turret] vessel, belong to JOHN ERICSSON."

To this first turret vessel we now come. Such a device had been offered by ERICSSON, in 1854, to NAPOLEON III., and in the fall of 1861 he proposed it to our Navy Department. By extraordinary energy and executive skill, the *Monitor* was launched, with steam-machinery complete, a hundred days from the laying of the keel-plate and the almost (if not quite) providential manner in which it arrived in Hampton Roads, just in time to drive back the Confederate iron-clad *Merrimac*, constitutes one of the most dramatic coincidences in the history of warfare, and certainly one of the most important, for it may well be that, but for its opportune arrival, the fate of this nation, and through it of the world, might have been gravely altered for the worse. The history of invention will be searched in vain for another such radical departure which proved so instantly and momentously successful.

A fleet of new *Monitors* was built with extraordinary rapidity after the victory at Hampton Roads. Six of them, in Charleston Harbor, within 52 days, were struck by hostile shots an aggregate of 69 times, without one penetration of side armor, turret, or pilot house. Their services through the rest of the war were very important, and revolutionized naval warfare.

ERICSSON then designed for defensive war a new craft called the *Destroyer*, 130 ft. long, carrying a submarine 16-in. gun 30 ft. long, which discharged a projectile weighing 1,500 lbs., and contained 300 lbs. of gun-cotton, against an iron-clad's hull, beneath the customary water-line armor belt. Little has since been heard of it, however. Whether more will be heard of it in case of war, remains to be seen.

The variety of ERICSSON'S work is shown by the fact that at the World's Fair of 1851 he exhibited, among devices not yet mentioned, an instrument for measuring distances at sea; a hydrostatic gauge for fluids under pressure; a gauge for the volume of water passing through pipes; the alarm barometer; a pyrometer; a measure for fluids by the velocity with which they pass through definite apertures; a sea lead for use without rounding the vessel to the wind. For the Centennial Exhibition of 1876 he amused himself by preparing an elaborate and costly volume of 600 quarto pages, containing a full record of all his inventions and contributions to science. But few copies were printed, all for private distribution, and it is now quite rare. So glorious a record of one man's work was never prepared before or since.

Amongst his scientific investigations are remarkable computations of the influences tending to retard the earth's rotary motion, including the weight of material taken from below the earth's crust and piled above it by the hand of man.

Of late years Capt. ERICSSON had devoted himself to the investigation of a subject which is as yet in its infancy, but which has already still further added to his honorable reputation, and may yet prove his greatest claim to fame, viz., the investigation of solar heat, the determination of the mechanical energy which the sun has in store for mankind when the coal fields become exhausted, and how best to apply it. A sun motor, illustrated in Fig. 3, erected by him in 1883, on his premises in

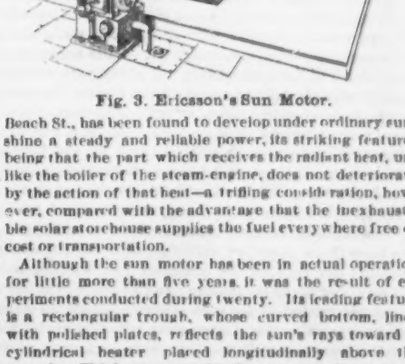


Fig. 3. Ericsson's Sun Motor.

Beach St., has been found to develop under ordinary sunshine a steady and reliable power, its striking features being that the part which receives the radiant heat, unlike the boiler of the steam-engine, does not deteriorate by the action of that heat—a trifling consideration, however, compared with the advantage that the inexhaustible solar storehouse supplies the fuel everywhere free of cost or transportation.

Although the sun motor has been in actual operation for little more than five years, it was the result of experiments conducted during twenty. Its leading feature is a rectangular trough, whose curved bottom, lined with polished plates, reflects the sun's rays toward a cylindrical heater placed longitudinally above the trough. This heater contains the steam or air employed to transfer the solar energy to the motor by cylinders provided with pistons and valves resembling those of ordinary steam engines. The bottom of the trough, as described by ERICSSON, in various communications to *Nature*, consists of straight wooden staves, supported by iron ribs of parabolic curvature secured to the sides of the trough. On these staves are fastened the reflecting plates of flat window-glass silvered underneath. In the motor illustrated, the trough is 11 ft. long, and 16 ft. broad, including a parallel opening in the bottom 12 ins. wide, the heater being supported by vertical plates secured to the truss. The heater is 6¾ ins. in diameter and 11 ft. long, exposing 1,274 sq. ins. to the action of the reflected solar rays. The reflecting plates, each 3 ins. wide and 26 ins. long, intercept a sunbeam of 23,400 sq. in. section. The trough is supported by a central pivot, around which it revolves. The change of inclination is effected with the most perfect ease by a horizontal axle, as the entire mass is accurately balanced. The motor is

a steam-engine with a 6 x 8 in. cylinder. Its average speed during the trials of 1883 was 120 revs. per minute, the absolute pressure on the working piston being 35 lbs. per sq. in. The steam was worked expansively in the ratio of 1 to 3, with a nearly perfect vacuum kept up in the condenser enclosed in the pedestal which supports the engine frame.

The brief and just comment of Capt. ERICSSON on his motor is that, in view of the facts set forth, "experts need not be told that the sun motor can be carried out on a sufficient scale to benefit very materially the sunburnt regions of our planet." Its operation in 1883 enabled him to prove that the calculations made by certain French scientists, assigning to the solar surface a comparatively low temperature, were incorrect, and that NEWTON'S far higher estimate on the same subject must be accepted. The elaborate and delicate investigations by which the solar temperature was measured we cannot summarize. Suffice it to say that ERICSSON found the sun's temperature to be 3,000,727° Fahr. against NEWTON'S 2,936,000° Fahr. of water, while various French savants had attempted to establish that it was only 7,000° C.

ERICSSON lived for a quarter of a century in a wide, cool, old-fashioned house, on what was formerly the fashionable St. John's Square, but which has been for many years occupied by the enormous freight station of the New York Central & Hudson River R. R., with the surrounding streets all but deserted by well-to-do residents. He lived a most retired life, refusing himself to all but a very few intimates.

For many years it was his custom to take exercise in the street at night only, after working sixteen or seventeen hours over his studies and inventions, but in the last two years he kept up his strength by a system of calisthenics like that in the public schools, which he practised in his house and in his yard in the rear of the house.

His health was generally good, and he lived almost exclusively on a vegetable diet. He worked steadily up to the time of his illness.

His funeral took place at Trinity Church, and was attended by a large body of distinguished men, an official delegation of the American Society of Mechanical Engineers, and a small informal delegation of the American Society of Civil Engineers, of which he was elected an Honorary Member in 1879.

The Servis Tie-Plate.

There are at this moment something like 200,000 miles of track in the United States, of which upwards of 160,000 is main track. Each mile requires on an average say 350 new ties per annum, making the enormous aggregate of 70,000,000 ties which are consumed annually within the United States. Still larger estimates are often made, but we see no grounds for them. Neither do we see grounds for the periodical alarms as to the drain upon our timber supply to furnish these ties. Assuming that it requires 40 years for a tie to grow to the proper size for a tie, which is a liberal estimate, it has been calculated that a strip 200 ft. wide along each mile of track in the United States, if heavily planted with timber, would keep it forever supplied with ties at the present rate of consumption. This seems to us rather an under statement; but at the present time, counting only half the area of the United States as capable of growing trees, or say 1,500,000 sq. miles, there is as nearly as may be 7½ sq. miles of tree growing land for each mile of track in the United States, neglecting as much more of non-tree-growing (and largely arid) land. This area is equal to a "strip" 39,600 ft. wide along each mile of track. Allowing a 400-ft. strip instead of 200, to be required to keep track supplied with ties, this requires only about 1 per cent. of the potential tree-bearing area to be given up to tie-raising; and as there is at least that proportion of the area which is fit for no other purpose, and as the timber thus raised is useful for fuel supply as well as ties, there seems no great ground for immediate alarm.

But the railway mileage is increasing with enormous rapidity, and so likewise is the area of land required for cultivation or grazing. There is thus a continually decreasing abundance of supply, besides which, tie maintenance is under any circumstances one of the most serious items in operating expenses, not only for the direct cost of ties, but for the indirect cost of disturbing the roadbed to take ties in or out. Moreover, there is an immense mileage for which no other than soft-wood ties are conveniently accessible, and much also on which the cost is disproportionately great owing to unfavorable location.

Therefore, while we have little belief in the alarmist cries about an approaching wooden-tie famine, it is a great object for any road, even if it were furnished its ties for nothing, to prolong their life as much as possible. Probably, also, the coming tie is a steel tie; but this will not come for many years yet on any considerable scale, nor at all until the cost of steel has fallen much below what it is now. For the rest of this century at least, the wooden tie will be practically universal.

It is therefore highly important to prolong the life of ties as much as possible for economy, and to prolong their wearing power, so to speak, on the ground of safety; for it is unfortunately true that

Fig. 1.

long before a tie approaches a rotten condition throughout, it becomes rotten in the spike-holes and "cuts" i. e., locally rots under the edges of the ties, constituting a serious addition to the danger of travel, which shortens the life of most ties a year or two.

There are two possible methods of reducing these evils, by chemical and mechanical protection of the fibre. The chemical protection consists in impregnating the tie with creosote or chloride of zinc (the two best processes) or, less effectively, with other chemicals. The mechanical protection consists in

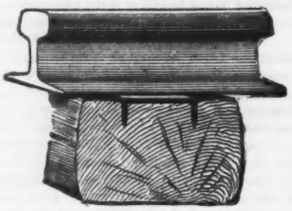


Fig. 2.

some device like the Servis tie-plate, which we illustrate (Figs. 1 to 3). There can be no reasonable doubt that of the two the chemical process is the more effective: that is to say, a well creosoted tie, otherwise unprotected, is better than an untreated tie protected by any kind of tie-plate; but then, the creosoting process is by far more expensive, besides which there is one great evil which it does not promise to cure any better than the tie-plate—local rotting and cutting of the tie, especially if of soft wood. The

Fig. 3.

creosoting process requires an extensive plant. Ties have to be shipped to the works, prepared, and then, with weight largely increased, re-shipped to destination. This explains why such processes have never been extensively introduced for tie timber.

To determine how effective a mechanical means of tie preservation is likely to be, we must consider how a tie is destroyed. The tie either rots out by the ordinary decay induced by fungi, as ordinarily happens with oak; or it "cuts out," viz., is worn and abraded under the rail, so as to become worthless before becoming decayed, this abrasion hastening a process of local rot which greatly aggravates the cutting proper. Such is the course with cedar. Timber of trees most used for ties is formed of a series of concentric rings, composed of longitudinal fibres, while the rings are held more or less closely together by radiating fibres called "medullary rays." The rail, working backwards and forwards, up and down, breaks the connection between the rings and separates the component fibres. Dust, sand, and grit get in between them, and the yare then actually worn out, as it were, by two millstones. The separation of the fibres also permits moisture to enter into the wood and so to provide the requisite favorable conditions for fungus growth or decay. If, then, this separation of fibres can be prevented, it is evident that our extensive forests of cedar, pine, chestnut, and other durable but soft woods could be more extensively utilized for ties than they are now. This is what the Servis tie-plate aims to accomplish, and seems to us to have a fair chance of accomplishing. The plate, or rather channel, is of steel, 8 ins. long, 3⅝ ins. wide, ⅜ in. thick, and with flanges ⅝ in. deep. They weigh in the neighborhood of 2 lbs. each. Spike-holes at the required width for base of rail are previously punched. Fig. 1 shows the tie-plate loose (but with disproportionately long flanges); Fig. 2 the plate in (position also with flanges somewhat too long.) Fig. 3 shows the track with tie plates in position. The plates are inserted under the rail, lengthwise with the tie, when the first passing wheel drives the channel into the wood and brings the plate "home" to a flat bearing. The flanges thus grasp the fibres in a bundle and prevent their separation. No rubbing or movement of the rail taking place on the wood, the rings are not disturbed, consequently mechanical disintegration of the wood does not take place, and the tie serves its full life until actually decayed. It is claimed that cedar ties, which cut out in 4 years, pine ties, which give out in 5 years, and chestnut, which fails in like manner in 6, will when protected by the tie-plate last their full life against rot, of say 8 to 10 or even 12 or more years.

But this is not all that the tie-plate seeks to accomplish. Under ordinary conditions, the vertical movement and lateral thrust of the rail tend to draw the spike upward and to push it sideways, the resultant action being to enlarge the hole and loosen the grip. If the wood be soft, the spike-hole is soon so much enlarged that the spike must be withdrawn, and driven into a new hole; and the tie eventually taken from the track, because there is no more space in which to drive spikes, although otherwise sound. With the Servis plate, it is claimed that as the rail no longer sinks into the tie, the spikes are much less likely to work up; especially as the spike cannot be pushed sideways because the plate through which it is driven holds it.

Again, as respects safety: At present the rails are held from spreading by the outside spikes only, and from tipping over by the inside spikes only. All rails on old ties will be found to be considerably tipped over from the vertical. With the plate, both inside and outside spikes are yoked together, so that rails can move sideways only by shearing the heads of both spikes, and the flanges of the plate through the wood; while, as the base remains persistently horizontal, the shank must remain persistently vertical. Cedar ties, which heretofore have always been condemned for curves, and tolerated on tangents only as a last resort, are claimed to be, with the Servis plate, as effective and durable as the best white oak; nor does the claim seem in any way intrinsically unreasonable.

An adverse criticism sometimes made against the tie-plate is that of noise; but the objection is at best a minor one, and we are assured and believe has no real foundation. Standing close by the track where ties are equipped with the plate, one can barely distinguish by sound the protected ties. On a train the difference is absolutely indistinguishable. A good reason for this is evident. The flanges are buried in the wood, and the plate itself rests on it, so that it is not free to vibrate, and consequently does not give out sound, or so little as to amount to nothing.

These plates are in successful use on many miles of road in the United States and Canada, and their use is rapidly extending. Among the principal companies now using them are: The Intercolonial with 100 miles of track with plate, the California & Arizona, Atlantic & Pacific, and Maine Central. Many other roads are now giving them trial, and we are unable to see any reason why they should not prove most useful and effective for all soft-wood ties at least. There is, of course, the objection that they cut two new grooves for local rot to start in; but there is this difference between any rot thus caused and rot around the spike or under the rail—that it does not tend to become aggravated by motion and play of the metal adjacent to the rot.

The plates are manufactured and sold by the Dunham Manufacturing Co., of Boston and Chicago, from whom all further information can be had.

Rainfall in the Western Arid Regions.

The very valuable report just presented by Gen. A. W. GREELY, Chief Signal Officer, to the Secretary of War, contains information shedding a much more favorable light than heretofore on the agricultural prospects of our "arid region," which can hardly fail to attract great attention. The report was called out by a resolution of the Senate calling for all the information there was as to maximum, minimum, and mean monthly rainfall in (1) the States bordering on the Pacific, Washington, Oregon, and California, and (2) the States and Territories along our Mexican boundary, Arizona, New Mexico, and Texas, with Indian Territory It being obviously impossible to make a proper study of the latest information as to these States and Territories without including also the intermediate ones, Idaho, Nevada, Utah, Colorado, and Wyoming, Gen. GREELY extended his investigation to cover these regions also, but he unfortunately (as it seems to us) failed to still further extend the scope of his investigation by including Montana, Dakota, Nebraska, and Kansas, and thus make it complete for the entire debatable region west of the Louisiana-Minnesota tier of States. What is given is quite enough, however, to be regarded as very gratifying and important, and as it is, the area studied covers nearly one-half the total area of the United States, which is now inhabited by about 4,000,000 people, against considerably over 60,000,000, probably, in the other half.

Fifteen charts embody the conclusions of the report, showing by "contour-lines" the areas of equal rainfall. These are based on reports averaging 7 yrs. 3 mos. each for 661 stations, an unexpectedly large aggregate of material. The value of such records was never better illustrated than by the proof these give that the area of naturally arable land in this great region is much larger than was supposed, the area with rainfall less than 10 ins., shown on the 1880 census maps as 241,000 sq. miles, being reduced to 126,000, or only 52¼ per cent. as much, and the total area below 15 ins. is reduced from 686,000 sq. miles to 385,000 or to only 61½ per cent. as much. The following are some of the more interesting passages of the report:

An examination of the charts of maximum annual rainfall and minimum annual rainfall of these regions, as presented herewith, shows clearly that rainfall conditions are considerably more equable than has been generally believed, so that the isohyetal lines are quite as regular on these charts of maxima and minima conditions as on those of average conditions. The minimum rainfall has never reached zero for any year, and annual or seasonal rainfalls less than 1 in. have occurred in southwestern California and southwestern Arizona at few stations only.

Another great value of the charts is the bringing to general attention and consideration very extensive areas of country in what has been known as the arid region, where late and careful observations have shown the rainfall to be far greater than has been usually attributed, and thus transfer these areas to the sub-humid districts.

The great extent to which misapprehension as to the rainfall conditions of the arid regions has been corrected by these charts is evidenced by the fact that the area on which the mean annual rainfall is less than 10 ins., shown on statistical maps of the tenth census at 241 000 sq. miles, has been reduced to 126,000 sq. miles, while a similar reduction is shown in the area of country where the yearly rainfall is between 10 and 15 ins., which, given in the census chart at 385,000 sq. miles, is now limited to 259,000 sq. miles. In other words, the area over which less than 15 ins. of rain falls annually has been reduced almost a quarter of a million (241,000) square miles. A large area of country charted on the census map as having an average rainfall of less than 5 ins., now entirely disappears in Texas, New Mexico, Utah, and Oregon, and is very materially reduced in Nevada, Arizona, and California.

Observations over a small, compact agricultural area of South Australia afford very reliable data as to the effect of rainfall upon annual wheat yields. It appears from these observations that 12 ins. of rain in the six winter months produce 6 bushels of wheat per acre, and that for every increase of rainfall of an inch, a like increase occurs in the average production of bushels of wheat per acre.

It has been pointed out by the Director of the Geological Survey that the arid region of the United States includes more than four-tenths of the entire country, excluding Alaska. It is believed that the accomplished Director unintentionally overstated the case when he advanced the idea that those regions should be classed as arid or incapable of successful agriculture without irrigation where the rainfall is less than 20 ins., annually. The statements put forth by him that with 20 ins., agriculture will suffer drought, and will be fruitless many seasons in a long series, is equally true of regions over which as much as 25 or 30 ins. fall annually. Indeed, during this very year, sections of the country where the annual rainfall ranged from 30 to 50 ins. have been visited by a most serious and protracted drought, which proved most disastrous to agricultural and other kindred interests.

The point at which a region may be classed as arid and unfit for successful cultivation should be lowered, it is believed, to 15 ins. The fact that wheat can be grown without irrigation in a country where the annual rainfall is less than 20 ins. is evidenced by official statistics from Dakota, which show that wheat is grown by tens of millions of bushels yearly in sections where the rainfall ranges from 20 ins. downward. Indeed, the arid region limit, based on 15 ins. mean annual rainfall, is a most reliable one in that region, as is evidenced by the fact that over 3,000,000 bushels of wheat are now grown annually in counties where the rainfall ranges from 15.1 down to 13.8.*

The report of Major POWELL states that in Utah less than 3 per cent. of its lands can be cultivated by irrigation. Thirty years since it was argued that the prevalence of alkaline matter in the soils rendered it evident that the whole country was worthless for agricultural purposes, even if sufficient rainfall prevailed, or water for irrigation was available. Experience has shown the fallacy of this statement, and it is now admitted that with water the greater part of the plateau lands are suited for cultivation.

Perhaps the most careful observations in connection with the effect of rainfall upon pasturage have been made in Australia, the question being very important, owing to the immense arid regions in that country. It has been set forth, and probably with a fair degree of authority, that annual rainfall, is a most reliable index as to the pastoral capacity of a country, since grass benefits by rain at any season, although it is not to be denied that a more equable distribution throughout the year is much better than an unequal one.

Australian records show that in that climate land favored with less than 10 ins. of rain a year is quite valueless without irrigation. The truth of this remark is borne out in a measure by the uplands of Castile, Spain which, the average rainfall being less than 10 ins. a year, are of but little value. In Australia the small pastoral capacity of an arid region is shown by the fact that up to 10 ins. only one sheep per square mile can be carried for each inch of rainfall. From 9 to 13 ins., however, the increase is about 20 sheep a square mile, and for the remaining 7 to 20 ins. of rainfall, the increased carrying capacity is about 70 sheep per square mile.

It has been estimated that the sandy land in the San Joaquin Valley, California, would feed about one sheep to the acre in the natural state, but when irrigated and growing alfalfa it carries twenty.

The statement put forth by the Director of the Geological Survey, that over 20 ins. of rainfall is necessary for the growth of forests, is probably correct, and the conditions of temperature and soil being constant, the extreme limit of the timber regions would not differ materially from the mean rainfall line of 20 ins.; but as is well known, the timber regions have been materially reduced in area by fire.

The question of control of water supply for irrigation assumes a magnitude far greater than is usually assigned to it, affecting as it does the future agricultural interests of one-third of the area of the United States. This question, which concerns the interest of millions of people, cannot be satisfactorily discussed and arranged without a knowledge of the mean annual rainfall which falls over the area of each particular drainage basin.

The extreme value in the arid region of every inch of rainfall can hardly be appreciated by the population of well-watered countries. Since this is a question which affects four-tenths of the area of the United States, there seems no doubt but in the future the interests of such an enormous area will concur in urging upon Congress the question of State control of irrigation. In one of the governments of that country which most resembles the United States (Australia) this policy has lately been taken —by the Government of Victoria. In Spain it is calculated that every 5 ins. of rainfall that can be collected off a given catchment area and brought to market is worth the same area of first-class irrigable but unirrigated land. The question which may arise between Nebraska and the Territories comprising the head waters of the Platte has already greatly excited the public mind in Australia on the question as to whether South Australia has any right to have water flowing in the Lower Murray.

(TO BE CONTINUED.)

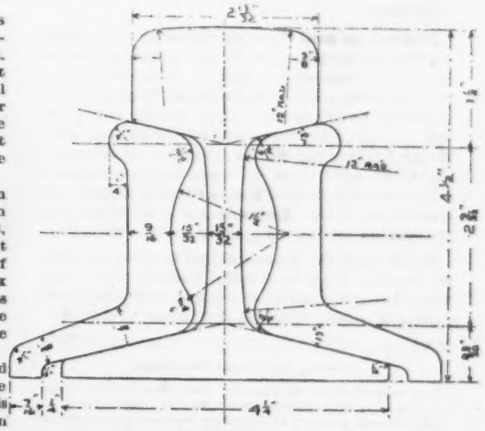
ON March 13, 1888, the day following the great blizzard the temperature in New York City was 9°. On March 13, 1889 it was 65°.

*See "Resources of Dakota, 1887," an official publication.

Standard Rail Section, Kentucky Union Ry.

The accompanying engraving supplements the extensive information as to current tendency in rail sections which we gave last week, by a carefully designed section recently adopted by W. A. GUNN, Chief Engineer for the Kentucky Union Railway. This important new line, as we trust most of our readers know, runs southeastwardly into a large and heretofore almost wholly undeveloped region of eastern Kentucky. As any one will see by looking on the map, the eastern quarter, or thereabouts, of the State has been heretofore absolutely without railways, being by far the largest area east of the Mississippi which has remained without them. It is, however, a region very rich in both minerals and timber, and this new road will at last open it up, and connect it with the rest of the United States; whence the name, Kentucky-Union.

About 10,000 tons of the section illustrated are now being rolled at the Carnegie Works. Since our



Rail Section for Kentucky Union Railway.
W. A. GUNN, Chief Engineer.
(Half full size.)

engraving was prepared, we learn that a slight change has been made in the angle bar section, its thickness in the center being made ½ in. instead of 9-16. This brings the outer vertical face of the angle bar directly under the vertical side of the rail. The rail is nominally 63 lbs. but really weighs 63½ lbs. or almost precisely 100 tons (of 2,240 lbs.) per mile.

Most of the modern tendencies are visible in this section, viz., low, wide head, vertical sides, sharp corner radius (we think it might well have been a little sharper), 12 ins. radius for top, and not too great an excess of weight in the head. The neck, however, seems rather thin, less than half an inch, and in this respect the section is perhaps open to improvement. Otherwise we think it will be generally admitted that the section is very carefully and well designed, and that the same is still more true of the angle bars, which certainly have their metal placed where it is calculated to do most good.

RAILWAYS IN JAPAN.—Japan is apparently not so free and open a country for foreigners as is sometimes supposed, judging from the following note from the *North China Daily News*, of Shanghai: "The railway between Tokio and Kioto, the Tokaido line, is expected to be opened to traffic this spring, and the *Japan Mail* discusses the important question which has been mooted, whether foreigners will be allowed to travel by it without passports. Obviously not, if the Government maintains its present *régime*, as nearly the whole of the line is outside treaty limits. Travelers easily get passports now, but have to state that they are travelling for the benefit of the health, or for purposes of scientific research, and every one who wants to go by rail between the two capitals cannot make this statement. It will be equally absurd to prevent foreigners using the line unless they do take out passports; and this, the *Japan Mail* uses as another and valid argument for the abolition of extra territoriality in Japan."

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Drawings for publication *should preferably be in plain black and white, considerably larger than they are expected to appear, with letters and figures in pencil only, all lines clean and bold.*

Coming Technical Meetings.

Engineers' Club of Kansas City, Mo.—Regular meeting, March 18. Secy., Kenneth Allen, 310 Bank Building.

Engineers' Society of Western Pennsylvania, Pittsburg, Pa.—Regular meeting, March 19. Secy., S. M. Wickersham, Penn Bldg.

Boston Society of Civil Engineers, Boston, Mass.—Regular meeting, March 20. Secy., S. E. Tinkham, City Hall.

American Society of Civil Engineers, New York.—Regular meeting, March 20. Secy., John Bogart, 127 E. 23d St.

Engineers' Club of St. Louis, Mo.—Regular meeting, March 20. "Street Car Running Gear," B. F. Clow; "Reminiscences of the Construction of the Union Pacific Railroad," C. H. Sharman. Secy., Wm. H. Bryan, 709 Market St.

New York Railway Club.—Next meeting, March 21. Rooms, 113 Liberty St., New York City.

Western Society of Engineers, Chicago, Ill.—Regular meeting, April 3. Secy., John W. Weston, Gaff Building.

Engineers' Club, Philadelphia, Pa.—Regular meeting, April 6. Secy., Howard Murphy, 1122 Girard St.

Civil Engineers' Club of Cleveland, O.—Regular meeting April 9. Report on Applied Science. Secy., James Ritchie, Case Library Rooms.

New England Railway Club, Boston, Mass.—Regular meeting, April 10. Boston & Albany Passenger Station.

PERHAPS there is no detail of railway practice in regard to which the ideas of half a century ago have proved more erroneous than the tie system for supporting the rails. It was at first supposed that very great solidity and permanency would be required, and that the ideal conditions would be to have the rails rigidly bolted down to solid rock. To attain this ideal many cuts were dressed off on the bottom in old days to support the rail directly. A large proportion of the earlier mileage of this country in Massachusetts, Pennsylvania, Maryland, and probably other States, was laid on rock "sleepers" in place of wood, with the idea that wood would be neither permanent nor solid enough to serve the purpose. When STEPHENSON was in this country and inspecting the Camden & Amboy track—which we may be quite sure was a poor affair indeed compared with modern track—he took his penknife, and tried to slip it in between unloaded rail and tie; and when he found that he could do so easily enough, he gravely shook his head, with some remark to the effect that that was a very bad defect indeed.

We have learned that these old ideas were in many respects radically wrong, and that, so far from such extreme precaution being necessary, very little care is needed to ensure perfect contact of rail and tie even for fairly good track. Thus it has naturally come about that not only is no effort made to ensure such perfect contact as was once thought needful, but rails and spikes are permitted to take their chances in a way that would certainly be thought rash enough even now, did we not know that it leads to marvellously few disasters. On all but the best track, the majority of spikes are more or less loose, on the inside at least, and the majority of rails have a slight cant outward, due to excessive cutting on the outer edge. This cant often materially increases the gauge, and always decreases by so much the factor of safety against overturning. We have known old rails in yards to be tipped over nearly 30°, and have their heads nearly half worn off in that position.

BUT it has occurred to many to question whether it was an absolutely necessary feature of the American type of rail section that its broad base should continue to be the only bearing surface by which the tie supported the rail. Some years ago a machine was introduced for grooving the top of a soft-wood tie and inserting a hard-wood plate, and it was then said to give very excellent results, although for some reason the device has never come into general use. We may in part suspect the reason to be the fact that even a hard wood tie is subject to the same evils in less degree, and that the connection of hard and soft wood was a loose and imperfect one; but it was admittedly a useful device, and it is very hard to see why such an iron or steel plate as is illustrated in another column will not be a much more effective device, greatly prolonging the life of ties, and making them while they last more safe and secure. It is a question whether the admirable efficiency of the wooden cross-tie has not made us too careless in recent years about giving it a reasonable chance for life by reinforcing its weakest point to correspond with the greatly increased loads which have been thrown upon it in the last two decades. The width of rail-base has been increased but slightly, about one-eighth at most, from 4 ins. to 4½ ins. The loads, speed and all considered, are very nearly double. The consequence is an early loosening of spikes and an early tendency for the rail to tip over outwardly, not unfrequently ending in so-called "spreading of rails," which might more properly be called rotting and crushing of ties. It seems to us that a metal tie plate of some kind is the proper mechanical remedy. Whether the one we illustrate this week is just exactly the right form for such a plate, we cannot undertake to say; but that some reinforcement of the wood in this manner is highly desirable, we believe.

THE amendments to the Interstate Commerce law, which we briefly noted last week, seem to be well planned, on the whole, to secure the more uniform enforcement of the provisions of the law, and to bring about that most desirable result, the permanence of railway tariffs. The requirement that three days' notice shall be given of any reduction in rates is no difficult obstacle in the way of a manager who is determined to make a cut; but it is a move in the right direction, and in a few years it may be possible to require a 30 days' notice for either advance or reduction in rates. One reason why permanent rates are for the public benefit, is that business men may know what they are to count on in the future. A 30 days' notice would give some time for shippers to make their plans in accordance with the proposed changes.

The provision for the publication and permanence of joint through tariffs was manifestly necessary to make the law clearly applicable to a very great amount of interstate traffic; and its passage was strenuously urged by the Commission.

The penalty clause provides: (1) That any officer or employé of a railway company who shall transgress the law in any particular shall be fined not more than $5,000; and that if the offense "shall be an unlawful discrimination," imprisonment for not more than two years may be added to the penalty. (2) That any officer or employé of a railway company who shall, by any form of under billing, enable any shipper to obtain transportation at less than the established rates, shall be liable to fine and imprisonment as above. (3) That the same penalty shall be applied to any shipper who shall obtain a rate of transportation less than the established one, or who shall induce any carrier to discriminate in his favor and against any other shipper in rates of transportation.

WE were disposed last week to question the wisdom of providing the penalty of imprisonment for "unlawful discrimination" chiefly because the clause appeared to apply to discrimination against localities as well as against persons. A more careful inspection of the law seems to indicate that this may not be the case. It certainly should not be, without very carefully drawn provisions, as the task of making rates which shall do exact justice to every locality in the country is one impossible for anything short of infallibility to accomplish. The necessary discrimination also between different classes of traffic, so as make rates proportionate to what the traffic can bear, is almost certain to cause complaint; and to draw the line between what is just and what is unjust discrimination is a well-nigh impossible task.

At the same time, there is discrimination practiced for which those guilty amply deserve imprisonment; as it is a species of fraud which certainly deserves severe punishment. While this amendment might conceivably open the door to abuses, if its enforcement fell into bad hands, it promises also to remedy the abuses of serious magnitude already existing; and so long, at least, as the present able Commission have the administration of the law, we have every belief that its general results will be good.

THE underlying cause for the addition of imprisonment penalties, and in our judgment a quite sufficient one, is no doubt this—that it is the only practical way of bringing to a realizing sense of their personal responsibilities the host of minor agents, with more or less power over rates which they have been in the habit of exercising in a very lawless fashion. Mere fines, which their companies have to pay, will have no terrors for them: They have been too long in the habit of lightly provoking rate wars which will certainly cost millions to be powerfully impressed by the danger of fines which may or may not cost thousands. Their mental attitude is very much that of the Irish absentee landlord, who wrote to his agent: "Tell my tenants that if they think to terrify me by threatening to kill you, they are very much mistaken." But a probability of having to go in person behind prison bars, unless they can transfer the responsibility and danger to some higher official who has ordered their acts, will tend to put a very different face on the matter, and induce a change in mental attitude which will lead to very different practices. As the loose way in which these companies plunge into warfare with each other

J. Ericsson

is in its essence truly criminal, it is more than likely that either such practices will be otherwise checked or that criminal penalties will be in time still further extended.

THE "Transactions" of the American Society of Civil Engineers now fill eighteen volumes, each volume to January, 1887, including the papers of one year. A subject-index covering the contents of these volumes would be a valuable and labor-saving publication that would be appreciated by every member of the Society, and by every engineer seeking information from this source. A brief subject-index referring only to the papers by name and author would be exceedingly useful, and the labor involved is so small that it is a matter of wonder that the Society has not done something of this kind for the benefit of its members, before this. A fuller index, giving heads of subjects discussed in all their bearings without special reference to title alone, would be a much greater labor, but its increased value would fully justify the outlay of time and printers' ink. The Institution of Civil Engineers issues an "interim Subject Index" annually, and at certain periods the fuller index referred to; and the fact that the last Brief Subject Index covers in 30 pages the material presented to the Institution between 1879 and 1888 shows that the task is not one of serious proportions. If the Society cannot find time at its headquarters to prepare such an index we would suggest it as a pleasing task to any member of the Society who has the leisure time at his disposal and the interests of his fellow-members at heart. If such an index, were properly prepared, the Society could not refuse to print it, and the compiler would be assured of the hearty thanks of every member of the profession.

As a hint to the compiler whom we hope may go to work, the "Brief Subject Index" of the Institution may be described as follows: The volumes are given in Roman letters and the page in Arabic numerals. The index gives first the subject as briefly as possible, then the full title of the paper and the name of the author, thus:—Air, compressed. "Notes on compressed air and machinery for utilizing it," J. Kraft. lxxix, 311. Cross-indexing is liberally used, as: Aeronautics, see Navigation, Aerial; Artesian well, see Well; Bessemer process, see Steel, etc. As some of our readers, otherwise willing, may not be familiar with the labor-saving methods of index-making, we outline this important part of the work as follows: First, have a number of slips of paper cut to say, 1½ x 4 ins.; then, commencing with the first volume, proceed to write on these slips the titles of the matter to be indexed, as this matter may come in the work. But judgment must be used in selecting the "catchword" so that it will cover the main subject of the paper, even when, as sometimes happens, this subject is not included in the title proper. For example, a paper may be entitled "The East River Bridge," and yet the use of compressed air in foundations, the manner of laying cables for a suspension bridge, the anchorage of these cables, and other matters of equal general importance to engineers may be fully described in this same paper. In all such cases the paper itself should be carefully scanned, and each separate subject cross-indexed, and referred to "The East River Bridge" or any other main title. When the contents of the volume or volumes are thus transferred to the index slips, the latter should first be divided alphabetically, and then each letter of the alphabet should be taken separately and again divided by its succeeding letters, as—Ab, Ac, Ad, etc. When this is done the slips should be arranged on a table, and the articles with a common main head grouped together by properly arranging the slips, and finally copied on sheets of paper or into a book. Numbered sheets, written on one side, should alone be used when the matter is to be printed. This looks a little formidable, as described; but it is really simple if systematically done; and if a good index is required, it is much less laborious than other methods sometimes followed. An index of authors' names and the papers written by them would be a very proper and valuable addendum to the Subject Index described.

John Ericsson.

It is almost pitiful to observe how small a ripple in the current of life in this city and country has been created by the death of one who was by far the greatest of living engineers; whose services to this country in its hour of need were outweighed in importance only by two or three of our great generals, if indeed by them; and who was the last representative of the few great men who may be said to have been the creators of the Age of Steam, no one of whom, even had he lived until to-day, could have more truly said than Ericsson of the marvels wrought by the use of steam, as Æneas said at the fall of Troy, "All these things have I seen, and a great part of them have I been." A column or so of obituary, largely incorrect, appeared in the dailies, and many prominent men attended his modest and unofficial funeral, including a delegation of the American Society of Mechanical Engineers and of the engineers of the Navy.

But even the American Society of Civil Engineers, of which ERICSSON had been an Honorary Member since 1879, and which might have been expected to be especially prompt in paying honor to his memory, took no steps to express as a body that interest and respect which all its members feel, by a regrettable and almost inexcusable oversight, being represented only by a few individual members, while the tribute of the general public has been merely a moment's sympathetic comment, without perceptible pause in the rush of life.

It is safe to say that no man who had rendered even half as great services to the country and to mankind in a public and official way, could pass away with so little formal manifestation of a respect which is certainly universal. We cannot doubt that the suggestion that his body be returned to Sweden in the largest and finest vessel of our navy, which he did so much to create, will be acted on; nor that resolutions which have been already introduced for statues to his memory will in time bear fruit. Nevertheless, to any one who duly appreciates ERICSSON'S real greatness, it seems somewhat pitiful that his death, full of years and honors, should be so quietly received, when there are dozens of scurvy politicians or millionaires whose death would for the moment make considerable stir.

In part, however, the cause for this is easily understood. Capt. ERICSSON has for over a score of years lived an unusually retired life, immersed in his studies and experiments, and refusing even to see any except a few special intimates. His past achievements are not such as appeal very strongly to the imagination of the public, though engineers, at least, should appreciate them at their full worth: and, moreover, the fame of ERICSSON, as of all the really great, may be left to posterity. With far more reason than BACON he might have put in his will: "For my name and memory, I leave it to men's charitable speeches, to foreign nations, and to the next ages."

It is questionable if, keeping in mind also ERICSSON'S unusually long professional career, there be not a certain sense in which he may even be regarded as the greatest *engineer* who ever lived; in the sense, that is, of having combined great and era-making achievements with that "all-roundness" in design and in practical work which marks the difference between the professional engineer and the mere inventor. By the term "mere inventor," we do not mean that the inventor is less gifted or is to be less honored. Sometimes he is far more highly gifted, and is deserving of vastly more honor; but it is usually for some one invention or discovery of transcendent importance, or a series of such in the same general line, rather than for a variety of distinct if minor successes in many different lines, to achieve which requires general engineering knowledge and capacity as well as "mere" inventive aptitude.

Few men have united these distinct gifts in any marked degree. ERICSSON did so, conspicuously. So rare is such a combination that it has been rather the rule than the exception for the great advances in all arts to come, not from men who were already practicing them, and who might be regarded as professionally expert in them, but from outsiders who knew little about them practically until they had some inventive inspiration, which often did more to advance such arts than all the professional work of experts. The instrument-maker WATT—the greatest of all inventors if importance of result be the criterion—and not the many prior builders of *quasi* engines, created the steam-engine. The collier-lad STEPHENSON, with every chance against him, created the locomotive and the modern railway, to which "THOMAS TELFORD of Abingdon Street, and others of our loving subjects," who about that time were forming the Institution of Civil Engineers, were quite unequal, although they deemed themselves so superior to STEPHENSON that they never would admit him as a Member. And so we might go through a long list of men, great as inventors, and sure of fame from the overwhelming importance of single achievements, who were not really great *as engineers*, as distinguished from inventors. Even STEPHENSON, for example, showed singularly little of strictly engineering aptitude, if the truth must be told, in advancing beyond his early practice and improving details, after his strictly inventive work was done: and to his backwardness in this respect was due much that was mistaken and absurd in early English railway practice. He did not, for example, "catch on" to the merits of the "bogie," after a "bogie" engine had been built in his own shops from JOHN B. JERVIS'S designs, nor did he investigate and determine in time the capacity of locomotives on grades, which would have saved his lines millions of pounds sterling. And so of many other details. We say this, not to diminish his undying fame as the creator of the railway, but simply to point out how rare is the combination referred to, of great inventive genius and high professional skill.

It is the glory of ERICSSON that he was great both as an engineer and an inventor. He had the quick insight of the inventor, but he worked out his results scientifically, with a broad knowledge of engineering; and hence, not only do his inventions cover a very unusually broad and varied field, but they were very unusually and speedily successful. What, for example, can be more marvelous than that ERICSSON, at the age of 26, with no experience at all, should have been able in seven weeks to design and build an engine which was as good a second to STEPHENSON'S *Rocket*

as the *Novelty* and other engines built by him next year? Had that been his only claim to fame, the death of a man at no very advanced age (86) who had played so great a part as this in the creation of the railway system, which has since revolutionized modern life and made possible modern civilization, would be an event of no common significance, vividly recalling to us how short is the period within which the material elements of our civilization have been created, and how small a part of the ultimate triumphs of science it is reasonable to suppose have been already achieved.

ERICSSON'S next great invention, at the age of 30, the caloric engine, was, as an evidence of inventive genius apart from its material consequence, almost if not quite as great a one as WATT'S. It did not realize his expectations but it worked from the first, and thousands of his engines are to-day in use. It would alone entitle him to an honorable place on the roll of inventors.

The invention and introduction of the screw propeller, which followed four years later, and was perhaps ERICSSON'S greatest achievement, was another prominent example of his engineering skill as distinguished from inventive capacity. The idea, in fact, was not new, as was WATT'S separate condenser. Col. JOHN STEVENS, himself one of the greatest of engineers and inventors, had built a small successful screw steamer over thirty years before, the engines of which are still preserved. It does not appear that ERICSSON knew of these previous attempts, so that, even as an invention, the screw was probably strictly his own; but whether it was or not does not detract from the worth of his service to mankind, which was, that he thought out and realized *as an engineer* its immense practical advantages, and by his persistence and skill in design finally forced it on a doubting world. As a consequence, by an unusual unanimity, the world gives to ERICSSON the sole credit for introducing screw propulsion, although even STEVENS was not the first to suggest it.

Next in the list of great achievements came ERICSSON'S invention of the *Monitor*, first offered to the French in 1854, but in practical form created complete within the fateful 100 days which ended in the *Monitor-Merrimac* fight, and was followed by the reconstruction of the navies of the world. It does not admit of question that its design and construction in so short a time was the greatest service ever rendered by an engineer to a nation in an hour of need; and if it changed the fate of the war, as possibly it did, none was ever followed by consequences so important. Finally has come an invention, the fruit of profound study and experiment, of which the future and not the present must measure the true importance—the sun motor; and besides this again there are dozens of meritorious minor inventions and designs of which we cannot speak, some still in extensive use, and nearly all evidencing profound engineering aptitude and knowledge.

Few indeed are the men who have made any approach to such a combination of engineering achievements. As he was not an American, we cannot be charged with national prejudice when we declare again that we find it hard to see who among great *engineers* can be regarded as greater than ERICSSON; and although we cordially admit that several inventors have rendered more important single services to mankind, certainly none has rendered services so vitally important to this nation.

THE CAPE COD CANAL has been advanced nearly one mile during the past year, with a width of 200 ft. at top and a depth of 15 ft. About 7 miles remain to be excavated.

Extensions of the Illinois Central System.

The recent refusal of the Illinois Central Railroad Company to join the Interstate Railway Association caused much discussion in Wall street. The excuse offered by the company for its action was that under its charter the directors alone had the power to fix rates, and that "they could not delegate or transfer this power to others." In view of the fact that ever since the road began operations, the directors have had very little to do with the matter of rates, and that they always have delegated the power to make and alter rates to hundreds of other parties, from the president down to local freight agents, this excuse seemed exceedingly thin. Wall street has therefore busied itself with guessing what was the real motive of the directors in refusing to join the Association. The majority, of course, hold that President FISH and his colleagues are interested on the "bear" side of the stock market. A few declare that the company's managers are aggrieved because they were not invited to be present at the preliminary meetings for the Association's formation. But a reason considerably more plausible than either of these, but of which little has been heard, is the statement that the company's managers have planned to build some important extensions in the Northwest; and intend to carry out their plans, notwithstanding the opposition of the companies belonging to the Association with whom its proposed lines would compete, and of the bankers who have declared against any more railway building in the West until the existing roads can earn their living.

It is true, the annual report of the Illinois Central, just issued, states that no new extensions are in view. But for obvious reasons, the plans of railway corporations are seldom very fully unfolded in published reports; and though not "in view," the new extensions are perhaps not very far out of sight. There are at least four considerable extensions which we have every reason to believe have been more or less favorably considered by the Illinois Central Directors. One is for a line down the east bank of the Mississippi river from Cairo to Memphis, and considerable work was done on the surveys for it, several months ago. Another is the projected Wisconsin Midland railway from Madison, Wis., to the lumber and mining districts in northern Wisconsin and the north Michigan peninsula. Extensive surveys have also been made on this line. There was much said in 1887 of an extension from Sioux Falls, Dak., northwest, but this will probably not be seriously considered for a good while to come. More important than all these prophecies of possible work is the conjecture that parties interested in the Illinois Central will furnish a large part of the sinews of war for the proposed "Pacific Short Line." We expect to have more to say with regard to this enterprise, at an early date; but the main facts in regard to it are that it is a projected railway from Sioux City, Iowa, to Ogden, Utah, on which a very considerable amount has already been expended in surveys. The capitalists and "promoters" who are at the back of this enterprise declare, of course, that it is wholly independent of existing roads; but even if it is, it may not always refrain from alliances with other corporations, and there is no railway system so likely to take it up as the Illinois Central. It should be said that the new line will traverse a section not already well supplied with railways; and it will not, or need not, closely parallel any existing road. The only question, therefore, is whether the resources of the section of northern Nebraska and Wyoming through which the road is to run are sufficient to warrant its construction. Its projectors declare that this is the case, and that they are ready to prove their faith by putting up the money to build the road.

Now, if a road *can* be profitably built and operated through this section, its early construction is a matter of certainty. It is equally certain that from the nature of the case it must have an outlet to the east; and the Illinois Central system will be the most natural one. Naturally, therefore, the Illinois Central managers must feel much interest in the construction of this line; and for the traffic which they would thus secure for their line from Sioux City to Chicago they could well afford to lend some aid in the construction of the road. Straws show which way the wind blows, and the fact that Mr. L. H. CLARKE, formerly Chief Engineer of the Illinois Central system, is now at Sioux City as Chief Engineer of the Pacific Short Line, is not without significance.

On the other hand, and this is a most important point, capitalists who know the extent to which oppressive railway legislation has already gone in the West, and the prevalence of the sentiment which demands that it be carried much farther, are naturally slow about making investments in Western railways. The Illinois Central managers are of course conversant with these facts; and they are not likely to make any rash moves, to say the least, for the stockholders and directors of the Illinois Central are, as a class, conservative men, who hold their stock as an investment and not for speculation. But it is also to be remembered that there are good reasons for belief in the prospect of profits from railway building in the far West. The Union Pacific is making handsome gains. The Northern Pacific had an enormous increase in earnings last year over 1887. The Southern Pacific's gross receipts in 1888 were $48,853,208, an increase of 25½ per cent. over what they were in 1887. The traffic of the territory of Wyoming, through which the Pacific Short Line is to run, is already coveted by four great railway companies on account of the great mineral wealth which is awaiting development there. On the whole, therefore, the theory that the refusal of the Illinois Central to join the Interstate Association indicates that the company intends to put an extension policy in force at an early day, seems to be a very plausible explanation of this very regrettable action. It may not be so, and it must not be understood that we charge it; but it is at least the most evident inference from the evidence at hand.

Uniform Couplers for Steam Car-Heating.

We do not know what inspiring motives animated the writer of the following paragraph, which appears in the *Railway Review* of March 2, but such broad as well as personal statements demand a few words of correction:

> It was a sublime and inspiring spectacle for the inventors present at the last meeting of the New England Railroad Club, to have a certain professor get up and say "that he advised the railroad men of the country to use the Westinghouse air brake hose coupling for all steam heating purposes, because the patent on it had expired." What an incentive such advice is to the inventive genius, and if it was strictly followed, what progress would the technical schools of the country make! Where would be the many triumphs of American improvements in railroad appliances? If the giver of this advice and the promulgator of this noble theory had been acquainted with the practice on the subject he was talking about, he would have discovered that all of the railroads which have tried to use the device advocated for steam couplings have found it a most dismal failure. Even the owner of this "patent run out" device, will not use it for the couplings of his own steam heating system.

The personal attack here, of course, is upon Prof. LANZA, of the Massachusetts Institute of Technology and Engineer of the Massa-

chusetts State Railway Commission, who, in his remarks at the meeting above referred to, did advocate the Westinghouse coupler for steam car-heating, but not at all in the words which his critic misquotes above. Passing that, however, the statement above that the roads which have tried to use the Westinghouse coupling for steam heating purposes have "found it a most dismal failure," cannot pass unchallenged. At the meeting to which the above extract refers, Vice-President W. P. SHINN, of the New York & New England system, followed Prof. LANZA in speaking and said:

> We adopted the Westinghouse coupler because it was cheap and convenient. . . . . I never knew of any considerable amount of steam heating that had not some leakage. That has been partially overcome in this instance, and I think it will continue to answer the purpose until we are called on by the Commissioners to adopt something permanent, or until the roads in general agree on what is best.

Prof. LANZA states that it is also working and giving satisfaction on the Boston & Albany, and that he has not seen any coupling that worked better.

Now, as was shown in our report of the New York R. R. Club meeting (March 2, page 198) it is a lamentable fact that the movement toward the adoption of a uniform coupler for steam heating has accomplished nothing as yet, and does not seem likely to reach any better results in the near future, unless, indeed, the recent joint meeting of the State and Interstate Commissions should bring it about. There can be no question that lack of uniformity in couplings is at present the great obstacle to the rapid and universal introduction of steam car-heating.

As Prof. LANZA says, nobody is advocating the Westinghouse coupler because no one has any money invested in it. It is consequently for the pecuniary interest of a great many persons to misrepresent and decry its practical working, and of none to push and advocate it. The only persons who would make any money by its adoption are the stockholders of railway companies, who do not have much to say about such matters. Now, granting, for the sake of argument, that this or that patent coupler is slightly better than the Westinghouse, the question is, is it *enough* better to be worth paying for it six times what the Westinghouse costs? Is it *enough* better for its promotors to be able to induce all railway companies to adopt it? It is a well known fact that inventors are apt to magnify the evils which their devices are designed to counteract; and the steam-coupler men, with all due respect to them, are no exception to the rule. To hear some of the eloquent representatives of these companies talk is almost enough to convince the most sceptical that railway car heating by steam is a difficult, dangerous, and virtually impossible task, except with the single system which the speaker advocates.

But as a matter of fact, what are the main and only real requirements of a steam-heating coupler? They are only:

1. That it shall be durable, simple, not liable to sudden failure, and reasonably tight. All these qualities we know from long experience that the Westinghouse coupler possesses.

2. That it shall leak but little if any. This also is practically attainable. There may be somewhat more leakage with the Westinghouse than with some of the other steam couplers; but it cannot be said that there is enough leakage to constitute a serious loss of steam, and the nuisance can be diminished to small proportions by perfection of manufacture.

3. That water of condensation shall not collect in it to an objectionable extent, and especially not so as to freeze in it after steam is turned off. This end can at the worst be always attained by keeping the coupling higher than the contiguous pipes, so that natural drainage may clear it.

The fact that these three necessary ends can be attained in so many different ways explains the multiplicity of competing devices, each of which has its merits, and some of which are of course better than others. But we repeat that the dominating requirement is uniformity throughout the United States and Canada, and it appears clear to us that there is small hope of attaining this from any of the proprietary couplers, nor can we perceive any reason why they will necessarily answer the purpose enough better than the "free for all" Westinghouse coupler to make the difference worth talking about. It is to be remembered that the only parts which it is necessary to standardize are the contact parts proper, which are directly concerned with the act of coupling. Any desired additions or changes apart from this, to adapt the coupler more perfectly to its new special use, may be freely made by any one, without decreasing its value as a standard.

Prof. LANZA states that the various defects which the patent-coupler men claim to find in the Westinghouse coupler are wholly theoretical, and are not found in practice to be at all serious. Even if unsupported, his testimony as an impartial and expert witness is entitled to a fair hearing, and a presumption in its favor as wholly disinterested; but it is by no means unsupported. Unless and until it is clearly shown to be impracticable, why not leave the patent-coupler men to fight over the respective merits of ball joints, slip joints, hose and overhead couplings, and give the general introduction of steam heating a strong impetus by adopting the Westinghouse air brake coupling? In that way several hundred thousand dollars would be saved to the railway stockholders of the United States; and in view of the fact that these unfortunates got a pretty hard rub last year, such a saving might please them and really be worth making.

Inventors of patent railway appliances are very apt to magnify the vast benefits conferred on the railway companies by the use of their ingenious devices, and to make the prices for their goods on this basis. No doubt several steam couplers now offered are very excellent devices, but none of them is likely to be universally adopted until it is shown that its cost bears some reasonable ratio to the benefit which is gained over the simple, cheap, and effective device that has been proved excellent for an analogous use by long experience, and is now public property.

In other words, common-sense requires that that device should first be affirmatively proved inapplicable, not by two or three men's adverse conclusions, which are often made on hastily assumed grounds, but by a failure to favorably impress even two or three men whose opinion is worth attention. For it must not be forgotten that in all such cases the evidence of one man who gets favorable results and is satisfied justly outweighs that of eight or ten who do not get such results and are not satisfied. The last have probably omitted some necessary detail. Merely theoretical objections do not deserve consideration at this stage of the art of steam car-heating; and we repeat that the argument that the Westinghouse coupler will leak steam and collect water is also not effectual unless it is shown that the leakage is sufficient to cause some measurable loss in one way or another; that this loss is considerably more than with other couplers in like service; and that the water which unavoidably collects is sufficient to cause some sensible obstruction to the passage of steam.

CORRESPONDENCE.

Pile-Driving Formulæ.

14 *Mount Park Road, Ealing,*
LONDON, W., Feb. 25, 1889.

TO THE EDITOR OF ENGINEERING NEWS:

I have just seen the NEWS of Dec. 29, in which you propose the very simple pile formula:

$$L = \frac{2\,w\,h}{s+1}$$

where L is the safe load in pounds on one pile, w the weight of the ram in pounds, h the height of fall in feet, and s the final penetration in inches.

This, you will notice, differs from the Trautwine formula (which may be put thus)

$$L = \frac{50\,F\,w\,\sqrt[3]{h}}{s+1}$$

only in two respects:

(1.) You use the *entire* height of fall, while we use only its *cube root*.

(2.) Your factor of safety is embodied in your constant coefficients, while ours (F) is left to the judgment and to the peculiarities of the case.

It seems to me that the gain in simplicity secured by these two changes is at least offset by the resulting departure from the correct form.

As to the substitution of h for $\sqrt[3]{h}$, I cannot agree with you where you say, "We distrust all formulæ which, like Trautwine's $\sqrt[3]{h}$, are in direct and complete antagonism to theory. The hammer in falling stores in itself a certain force $w\,h$, and, barring the energy wasted, the average resistance against which the pile moves through s is measured by $\frac{w\,h}{s}$."

It is just the "barring" that, I think, renders our $\sqrt[3]{h}$ more nearly accordant with theory than your h.

In the first place, the ram does not reach the pile with the theoretical energy due to h, for much of this is lost in friction, resistance of air and vibration of guides, etc., on the way down; the relative loss no doubt increasing materially with the height of the fall. Of the remaining energy (the actual energy of *blow*) a large portion is wasted in lateral vibration of pile (especially if there is a considerable length above ground and the blow is not truly axial), in splitting the pile and in compressing not only the broomed head but the whole pile. The damage to the head, and the consequent loss of energy in mashing the bruised fibres there, and the further loss due to splitting the pile, must increase very rapidly with height of fall.

Again, the greater the fall, the longer is the lapse of time between blows, and the greater the loss of whatever advantage would be gained by a rapid succession of blows.

It is idle to attempt to ascertain, or even to estimate, each of these losses separately, as seems to be done in some of the formulæ where there were not enough "U. S." letters to go round; but on the other hand, it is certainly incorrect to ignore them, and our use of $\sqrt[3]{h}$, instead of h itself, is merely an empirical attempt to "lump" them.

While, therefore, the *cube root* of the fall (as in our formula) may be too *low* a power in many cases, the *fall itself* (as in yours) must, I think, be certainly too *high* a power, in *all* cases.

Nor can I think the use of a constant factor of safety an improvement, for it aims to fix one of the most unfixable factors of the case, giving, as I understand, the same factor of safety for a low brick storage shed, in ground free from vibrations or inundations, as for a lofty cathedral, with a tidal river on one side and the jar of railroad traffic on the other.

While our ignorance remains, we must use its factor; and the denser that ignorance, the greater must be both the factor itself and its range of variation. It seems to me, therefore, more scientific (or, which is really the same thing, more practical) to try to approximate to the "extreme" load, and leave the factor of safety to the judgment. The result is shabby, but I don't see that the case admits of anything better.

The weak point in all these formulæ is the unavoidable presence of the "penetration" in the divisor, even when "diluted" by the constant addition of 1, as in your formula and in ours.

Even if we had means at hand for accurately measuring this small quantity, how utterly impossible it would be to say how much of it was true "penetration" and how much brooming of head and compression of pile; yet the whole observed penetration is ordinarily so small that a trifling error in its observation, or in the estimation of the part due to crushing, is an important fraction of the whole; while the final result, or load, in your formula and in ours, varies precisely in inverse ratio to the sum of this insignificant thing and the constant 1, and in many other formulæ the penetration is the *sole* divisor. It is like measuring the parallax of a star with a 2-ft. rule.

Referring to the pile which you quote from, Mr. WHIT-

TEMORE, you exaggerate a little (if you mean to include your formula and ours) in saying that "according to any one of the established formulæ, the ultimate load would be three or four times as much, had driving stopped just before adzing off, as if it had stopped just after." At a depth of 18 or 19 ft. this pile went about .015 in. per blow *before* adzing, and .056 in. per blow after adzing.

From our formula we have

$$\text{extreme load in lbs.} = \frac{50 \times 2800 \times \sqrt[3]{6}}{1.015} \text{ and } = \frac{50 \times 2800 \times \sqrt[3]{5}}{1.056}$$

respectively, or say 199,000 lbs. before adzing, and 191,000 lbs. after adzing, while yours gives

$$\text{safe load in lbs.} = \frac{2 \times 2800 \times 3}{1.015} \text{ and } = \frac{2 \times 2800 \times 3}{1.056}$$

respectively, or say 33,100 lbs. and 31,800 lbs. respectively, or the same as ours would be with 6 for a factor of safety. The constant addition of 1 in the divisor, and the smallness of the penetration in this case, enable us both to give practically the same load before as after adzing.

While I was not consciously guilty of "special pleading" in behalf of our formula, I think, upon further reflection, that you are quite right in insisting that in the case of the Buffalo pile, the load (75,000 lbs.) under which the *first* settlement took place should be taken as the extreme load. For the settlement of ⅛-in. under that load, by compacting the ground under the pile, no doubt increased its resistance beyond that due to the driving, and it was *this* that enabled it to stand a further gradual increase of load (20,000 lbs. at a time, and 24 hours between successive additions) up to 100,000 lbs. without further settlement.

In looking up the original records of this case, I find that subsequent experience indicated 70 000 lbs. per pile as a safe load for piles similarly driven. Your formula,

$$L = \frac{2wh}{s+1}$$

gives 44,080 lbs. of safe load, which is very satisfactory.

I may be allowed to remark that the two "Trautwine formulæ" given in Mr. HERING'S table:

$$L = F\,60\,w\,\sqrt[3]{h} \text{ (if } s \text{ is inappreciable)}$$

and

$$L = F\,\frac{5\,w\,\sqrt[3]{h}}{s+0.083} \text{ (if } s \text{ is appreciable)}$$

are taken from our *earlier* editions and differ from the one now given:

$$L = \frac{F\,50\,w\,\sqrt[3]{h}}{s+1}$$

which is intended to apply to all cases.

All three of them, however, use the cube root of the fall, all leave the factor of safety to the judgment, and all are mere attempts to get somewhere near the facts and at the same time embody the broad theoretical principles of the case.

JOHN C. TRAUTWINE, JR.

[We cheerfully give our correspondent's views, which will be read with interest, but we fail to see wherein his facts and arguments even tend to prove that the simple formula:

$$\text{Safe load in lbs.} = \frac{2\,w\,h}{s+1}$$

is less useful or trustworthy than the more complex form:

$$\text{Safe load} = F\,\frac{50\,w\,\sqrt[3]{h}}{s+1}$$

And we must adhere to our expressed opinion that the factor $\sqrt[3]{h}$ is radically wrong in principle, and is liable to lead to dangerously heavy loads being placed on piles driven with low falls. For example, suppose three piles driven by a 2,000 lb. hammer, with final falls of 1, 8, and 27 ft. respectively, and final penetrations of ½ in. and 1½ in. in each case. By the respective formulæ we have:

		$h=1$ $s=\frac{1}{2}$	$h=8$ $s=\frac{1}{2}$	$h=27$ $s=\frac{1}{2}$
By $\frac{w\,h}{s+1}$	Safe load in lbs. =	2,667	21,333	72,000
By $F\,\frac{50\,w\,\sqrt[3]{h}}{s+1}$	" " " " =	F 66,667	F 133,333	F 200,000
Necessary value of F to equalize formulæ		25.00	6.25	2.78

When $s = 1\frac{1}{2}$ in. instead of ½ in. we have:

By $\frac{2\,w\,h}{s+1}$		1,000	12,800	43,200
By $F\,\frac{50\,w\,\sqrt[3]{h}}{s+1}$		F 40,000	F 80,000	F 120,000
Necessary value of F to equalize formulæ		25.00	6.25	2.78

The loss of resisting power by the increase of penetration from 0.5 to 1.5 ins. is in every case by either formulæ 40 per cent only, whereas, if in strict proportion to the theoretical energy the loss should be 67 per cent. thus making a considerable allowance for the superior resisting power of piles driven with low falls; but the resisting powers by the TRAUTWINE formula are inadmissibly great for low falls. Thus, a pile penetrating 1½ in. under a 1-ft. fall of a 2,000-lb. hammer will hardly bear safely any load at all. His formula gives an ultimate of 40,000 lbs. On the other hand, the simpler formula suggested by us does not give too high a value for safe load even for the highest fall given, 27 ft. (which is above the maximum of good practice) it being always assumed, of course, that the penetration has been running approximately uniform, and the pile is not noticeably broomed, without which, no engineer in his senses would think of using any formula to determine safe load. On the question of "factor of safety" we will have a word to say next week.—ED. ENG. NEWS.]

Cement Lined Water-Pipe.

DOVER, N. H., March 8, 1889.

TO THE EDITOR OF ENGINEERING NEWS:

I notice in Mr. FISHER'S letter, in your issue of March 2, that he says substantially that cement-lined water-pipe should be made of Portland cement and sharp sand only. I know of at least three systems of water-works where cement-lined pipe is used, which was made of F. O. Norton's Rosendale cement and sand, according to the following specifications:

The cement to be used shall possess quick setting qualities, shall be uniform in character and such as will ensure strong work, and shall be subjected to any test that the engineer may require. The cement shall be mixed with sand in the proportions not exceeding one of cement to one and one-half sand, for the lining and covering of the pipe, but joint work shall be done with pure cement or cement with slight admixture of sand, as the engineer may direct.

The piping has been in use for 10 years under pressure varying in the different systems from 55 lbs. to 90 lbs., and has been tested to 125 lbs., and even higher. The pipe gives perfect satisfaction, and the cost of repairs does not exceed that of cast-iron pipe, under similar conditions.

Respectfully yours,

L. L. GERRY.

PUBLICATIONS RECEIVED.

—*Address of Col. Wm. E. Merrill, President of the Engineers' Club of Cincinnati.* Pamphlet, 20 pp. A review of the world's progress in engineering during the year 1888.

—*Pocket Book of the Chapman Valve Mfg. Co.* Size 4¾ x 7½; 233 pp.; bound in leather with flap cover. Published by the Chapman Valve Mfg. Co., of Indian Orchard and Boston, Mass.

This is a very handsomely got up reference book, consisting of an illustrated catalogue of 67 pp, and an engineering appendix of 166 pp. The catalogue gives a description of the valves and hydrants, with cuts and tables of dimensions of various classes of these appliances. The appendix is divided into four parts: Part I: general engineering data; weights and measures; tables and circumferences and areas of circles; tables of squares, cubes and roots; logarithmic tables, specific gravities; stones, limes, and cements; iron; tables of weights; alloys, wind velocities, etc. Part II: hydrodynamics; properties of water; rainfall; pipes; pressure; friction; water motors; etc. Part III: heat: steam; evaporation; H. P. of boiler; power of engines; duty of pumping engines; sizes of chimneys; ventilation; heating, etc. Part IV: gas; properties of coals; gas holders; heaters and burners: iron sponge; natural gas. The various tables, formulæ, etc., have been collected from the works of reliable authors, and are such as will be especially useful to engineers, machinists, and all having to do with the construction or maintenance of work of any kind. The book is a very useful compendium of such tables and general information as a man likes to have ready to hand, and we think the hope of the publishers, that "it may prove of value as a book of daily reference," will be fully realized.

—*Catalogue of the Aerated Fuel Co.* Springfield, Mass. Process: Crude Petroleum with Air Blast for welding, tempering, annealing, enameling, and all kinds of forging and melting of metals, pp. 40.

This admirably prepared, printed, and bound catalogue belongs preëminently to the class of those which appear to be designed to convey information rather than for distinctly advertising purposes, and can be read with interest by any one.

—*School of Mines Quarterly.* January, 1889. Columbia College, New York City. This number contains the following papers: "The Oil Fields of Colorado," Prof. J. S. NEWBERRY; "Patent Process," EMIL SATREK; "A Brief Review of the Literature on Ore Deposits," J. F. KEMP; "The Transformation of Electricity into Mechanical Energy," W. H. ERB; "The Eruption of Krakatoa in 1883," JOHN I. NORTHROP; Notes on Some Chemical Qualities of Foundry Irons," C. A. MEISSNER; "The Manufactures of Chemical Fibre," E. A. CONGDON.

—"*Brass*" is the title of a gem of the printer's art setting forth the qualities and uses of the "Vesuvius" manganese bronze made by Messrs. B. H. & H. CRAMP, of Philadelphia. Photo-engravings show the main condensers of the U. S. cruiser *Baltimore*, made of six castings, weighing in the aggregate 12,604 lbs.; the main air-pumps of the same vessel, in a single brass casting of 4,517 lbs.; a propeller hub of 9,500 and a propeller blade of 4,600 lbs.—all cast by this firm from "Vesuvius" manganese bronze. Tables of tests of this metal are added showing a tensile strength of 100,551 lbs. per sq. in., and an elastic limit of 86,100 lbs. per sq. in. as the average of eight tests.

PERSONAL.

Mr. A. W. CORSON has been appointed City Surveyor of Norristown, Pa.

Mr. D. MACKENZIE, General Superintendent of the Mexican Central, has resigned.

Mr. A. C. BIRD has been appointed Traffic Manager of the Chicago, Milwaukee & St. Paul.

Mr. WM. H. LANGLEY has been appointed Commissioner of Public Works, at Detroit, Mich.

Mr. A. C. MCGRATH has been appointed Superintendent of Water-Works at Chambersburg, Pa.

Capt. WM. CORRY, one of the first directors of the Staten Island Shore Ry., died recently at Clifton, S. I.

Col. J. H. AVERILL, Superintendent of the South Carolina Ry., with headquarters at Charleston, S. C., has resigned.

Mr. J. W. WARDWELL has been elected Superintendent of the Coshocton & Southern; he is also Superintendent of the Cleveland & Canton.

COL. R. S. BEVIER, who died recently, was for many years President of the Owensboro & Nashville Road, it being a road which he first projected.

Mr. W. H. WHITTAKER, formerly general foreman of the Minneapolis & St. Louis shops at Albert Lea, has been appointed master mechanic.

Mr. G. H. MCCORD has been appointed Secretary and Treasurer of the Indianapolis Car-Works, at Indianapolis, Ind., vice Mr. FRANK RICHARDS, deceased.

Mr. RICHARD FORNST has been appointed Road master of the Wyoming division of the Union Pacific, vice Mr. E. BROWN, transferred to the Nebraska division.

Mr. J. F. CLARKE, Assistant Division Engineer of the Lake Shore & Michigan Southern, at Toledo, has resigned. Mr. CLARKE will go to Georgia to engage in business.

Mrs. WANDA MERRIMAN, wife of MANSFIELD MERRIMAN, Professor of Civil Engineering in Lehigh University, died at her residence in Bethlehem, Pa., on the 10th inst.

Mr. T. A. PHILLIPS, Superintendent of Transportation of the East Tennessee, Virginia & Georgia, with headquarters at Knoxville, Tenn., has resigned. Mr. E. B. PARKER has been appointed his successor.

Hon WM. WINDOM, Secretary of the Treasury, has resigned the presidency of the Atlantic & Pacific Ry. Co., the company which proposes to build the Tehuantepec ship railway projected by the late Capt. EADS.

Mr. M. C. KIMBERLEY has been appointed Assistant General Superintendent of the Northern Pacific, vice Mr. N. D. ROOT, deceased. He was formerly Superintendent of the St. Paul division and the Little Falls & Dakota Road.

Mr. F. L. COWIN, Assistant Superintendent of the Wyoming division of the Union Pacific until that office was abolished, has been appointed trainmaster of the Eighth, Ninth, and Echo and Park City districts, with headquarters at Evanston.

C. P. E. BURGWYN, M. Am. Soc. C. E., of Richmond, Va., has found time amid the duties of his profession to write a novel, which has been favorably noticed by the press, and which has already reached a considerable sale. It is so seldom that a Civil Engineer indulges in fiction that when he does, we may expect something novel indeed.

SOCIETY PROCEEDINGS.

American Society of Civil Engineers.—The regular monthly meeting was held March 6, President M. J. BECKER in the chair. The Secretary announced the following deaths: WM. S. BARBOUR, City Engineer, Cambridge, Mass., elected member in 1872; E. S. PHILBRICK, Boston, Mass., elected member in 1876; E. BAUMANN, Chicago, Ill., elected Associate in 1880.

The Norman medal, awarded to Mr. E. E. RUSSELL TRATMAN for his paper on "English Railway Track," was presented by the President.

A paper on "English Railway Track," by Mr. JAMES H. CUNNINGHAM, was read by the Secretary. The paper was practically a discussion of the above mentioned paper with the same title, which was read by Mr. TRAT-

MAN, at the last annual convention. It contained information in regard to traffic, earnings, and other financial matters which were not included in the original paper. While agreeing with Mr. TRATMAN'S opinions as to the use of the flange rail in the colonies and as to this form of rail being now the standard section of the world, he did not agree with him as to the adaptability of a flange rail track for English trunk lines, claiming that it had been tried and found unsatisfactory. He also thought that, as a number of roads of minor importance had been described in the original paper, too much importance had been attributed to the use of flange rails on these lines. As to the use of too heavy a track on the Scotch line which had been described, he thought it a little matter if the officers of that road had used too heavy a track and that it was not an example of English practice. The six important lines mentioned in the original paper represent an invested capital of over $1,662,500,000, and they earn a net annual revenue of nearly $77,500,000. The roads using the bull-head rail, including the six lines mentioned, represent an aggregate capital of more than $4,000,000,000, and a net annual revenue of $162,500,000. The stocks are popular and sound investments. The income is only maintained by vigilant economy, and every year more work has to be done for every dollar earned. He thought, therefore, that more weight should be given to the almost unanimous opinions of the engineers of these roads in favor of this form of track. While the tracks of different roads vary in detail, they are alike in important points; bull-head rails of 80 to 85 [90, ED.] lbs. per yd., in 30-ft. lengths, carried in cast-iron chairs weighing 40 to 56 lbs. each, which rest on ties 10 ins. x 5 ins. x 9 ft., spaced about 2 ft. 8 ins. c. to c. The system has gradually grown up during the past 50 years, during the first half of which period a great many kinds of track were tried, and experience has shown that the bull-head track is the "fittest" and it has therefore survived them all. The average gross receipts of the Irish lines are about $5,000 per mile per annum, while English roads earn four times as much, and these figures represent fairly, though perhaps roughly, the amount of traffic. The Scotch line mentioned has a traffic of only about $5,500 per mile. As regards the average weight of English track: roads having the average gross receipts of $21,250 per mile per annum, use a 40-lb. chair; the Midland Ry., with receipts of $26,250, uses a 50-lb. chair; and the Lancashire & Yorkshire Ry., with receipts of $40,000, uses a 56-lb. chair, the weight of the chairs increasing with the traffic; he did not think, therefore, that there was an unnecessary amount of metal in the track. The West Riding & Grimsby line, which the Great Northern Ry. had acquired, and had changed from an 83-lb. flange rail track to its standard track with bull-headed rails and heavy chairs, had become a part of the main line, and therefore a heavier track was needed. The English locomotive has been developed by the same process and under the same conditions as the English track, and while the question of wheel-base might have some bearing upon the track question, he thought the "bogie" [truck] question too large to be entered upon in his paper.

The discussion was opened by a brief paper by Mr. TRATMAN, replying to Mr. CUNNINGHAM'S objections in detail. He stated that his opinion as to the adaptability of flange rails to English trunk lines had been strengthened by the fact that one of the most important lines in England, the Northeastern Railway, which has been using a 90-lb. bull-headed rail in 40-lb. chairs, is now experimenting with a 90-lb. flange rail laid on steel crossties. This he considered to be a step towards the ideal track for railways with heavy traffic; and stated that in this country a similar step is about to be taken, as the New York Central & Hudson River road will lay about half a mile of track with its 80-lb. rails on steel ties. As to the roads of minor importance whose tracks had been described, the original paper was written to describe different classes of English track, and not only that of the trunk lines; he had not, however, attached undue importance to the use of flange rails on these minor lines, but had borne in mind the heavy traffic carried on light flange rails in this country. The change of the track of the Isle of Wight Railway from a 70-lb. flange rail to a 78-lb. bull-headed rail in 35½-lb. chairs, he thought proved nothing on either side, as there must surely have been some special reason for such action. If a 70-lb. flange rail bolted to the ties would not stand the very light traffic on this road in England, while a 60 to 70-lb. rail carried a heavy traffic with ponderous locomotives and trains of freight cars of 40,000 to 60,000 lbs. capacity in this country, there must be some other reason than the type of track. It might be a "very little matter" if too heavy a track had been used on the Scotch road; but that was where the want of economy was shown, and what was done in Scotland might very likely be done in England. He did not suppose the Great Northern Railway officials changed the track of the Grimsby line without good reasons, from their point of view; but for his part he questioned the necessity of such a change, as the 83-lb. flange rail ought to have made a sufficiently heavy track. He thought Mr CUNNINGHAM did not appreciate the vast difference between the English rigid wheel-base and the American flexible wheel-base, although the latter has been extensively adopted in England for locomotives and rolling-stock.

The Weather of the United States for the Month of February, 1889.

[As respects the elements of most interest to engineers.]

According to special returns from the Chief Signal Officer of the U. S. Army.

STATIONS.	Temperature. Degrees Fah.				Wind velocity. Miles per hour.			Precipitation. Rain and melted snow. Inches.		
	Average	Max.	Min.	Range.	Average.	Max.	Direction of Max. Vel.	Total.	Heaviest in 24 hours.	No. rainy days
Northern Cities.										
Northfield, Vt.	10.6	48	−32	80.0	9.2	40	SW	2.18	0.66	16
Portland, Me.	19.9	42	−8	50	8.4	53	S	2.74	1.50	12
New York City	26.6	50	2	48	12.1	48	W & SW	3.07	1.32	12
Pittsburg, Pa.	27.3	53	−1	54	7.4	33	W	1.58	0.67	16
Chicago, Ill.	19.1	48	−11	59	11.0	32	SW	1.31	0.44	13
Omaha, Neb.	21.0	53	−10	63	10.1	49	NW	0.23	0.21	3
St. Paul, Minn.	9.3	50	−25	75	6.4	29	W	0.31	0.07	9
Duluth, Minn.	7.3	53	−30	83	8.0	37	NE	1.38	0.53	12
Bismarck, Dak.	9.3	48	−34	82	9.4	56	N	1.48	0.74	8
Average.	16.7	49.4	−16.6	66.0	9.1	39.7		1.50	0.68	11.2
Southern Cities.										
Washington City.	29.0	54	4	50	6.0	27	NW	2.47	0.83	7
Louisville, Ky.	32.2	68	6	62	8.8	32	W	2.53	1.20	16
St. Louis, Mo.	30.0	69	zero	69	11.4	48	SW	4.78	1.85	9
Savannah, Ga.	46.6	81	24	57	7.0	26	NE	3.92	1.80	14
Leavenworth, Kan.	25.5	66	−5	71	7.4	34	NW	2.56	1.21	10
Jacksonville, Fla.	50.4	81	31	50	5.8	28	NE	3.85	0.93	13
Chattanooga, Tenn.	39.8	71	13	58	6.8	26	SW	5.10	3.36	6
New Orleans, La.	51.9	76	32	44	9.0	40	S	2.78	1.02	10
Memphis, Tenn.	41.4	77	17	60	7.8	36	NW	1.90	0.82	10
Palestine, Tex.	50.4	80	24	56	6.2	23	S	4.02	1.17	11
Average.	39.7	72.3	14.6	57.7	7.6	32.0		3.37	1.42	10.6
Western Cities.										
Helena, Mont.	23.8	61	−15	76	7.0	38	W	0.72	0.36	6
Port Angeles, Wash.	Not received									
San Francisco, Cal.	52.4	75	39	36	6.0	32	NW	0.72	0.59	6
Salt Lake City, Utah.	Not received									
Denver, Col.	28.6	61	−7	68	7.0	36	N & NW	0.70	0.49	9
Yuma, Ariz.	59.3	78	34	44	8.4	46	W	0.06	0.06	1
Santa Fé, N. Mex.	27.8	50	−1	51	6.6	30	N	0.53	0.20	6
Average.	38.4	65.0	10.0	55.0	7.0	36.4		0.55	0.34	5.6

Considering the heavy freight traffic on our Western roads, and the fast traffic over the trunk lines, he failed to see why, if a comparatively light track would carry such traffic here, a really good track of similar type, under proper conditions, would not carry the traffic of any road in England. As to the unnecessary metal in the English track, he thought the metal in the chairs to be superfluous. He was sure the American track was underestimated in England, as an English engineer, quoted in his original paper as saying that such a track would not stand under the heavy English engines, had written him for information as to the weight of track on our trunk lines, saying that he had believed that our track was something similar to that used in England for construction purposes. Mr. TRATMAN stated that he was sending particulars of 80, 85, and 90-lb. rails of American lines, and hoped to convince this gentleman of the excellence of a good American track. The English have a splendid track, but it is enormously expensive in first cost. As they have the track, however, and it is paid for, it would probably be false economy to replace it with a track of another type, and he did not wish to be understood as recommending such action, although Mr. CUNNINGHAM seemed to suppose so. For new lines, however, he would certainly recommend the adoption of a good flange rail track. In conclusion, he considered Mr. CUNNINGHAM'S paper a valuable addendum to his own on account of the information which it contained, but he did not think it had proved his own opinions to have been based on weak or unstudied foundations, nor had it shaken his convictions as to the superiority of the American type of track for railways in every country.

MR. T. C. CLARKE stated that the only advantage he could see in the English track was in its secure fastenings to the tie, the rail having no vertical movement in the chair, and the chair being very firmly secured to the tie. This prevented the rail from arching in the middle, with low joints, but if a flange rail could be fastened as securely it would give as good results. He thought, however, there would be some trouble in bolting a flange rail. Mr. BUCK thought it was mainly a question of the weight of the rail as a girder, and not of the form of rail. Mr. CROES and Mr. SLOAN spoke in reference to the trouble with the joints, and the latter stated that he had found the Fisher joint to cut the tie and was now using metal bearing plates on the joint ties. Mr. WEGMANN thought one advantage of the English chair was its broad bearing surface on the ties. Mr. BRENDLINGER referred to the Lehigh Valley road, with its Sayre rail, and stated that he, as well as the officers of the Pennsylvania road, considered it to be the best in the United States. Mr. BECKER thought the wooden keys of the English track would shrink and get loose, so that the track would not be as rigid as claimed.

In reply to some of the remarks which had been made, Mr. TRATMAN stated that there was little trouble with joints in England, owing to the fact that, by reason of the rigid fastening in the chair, the rail had no play back of the joint ties; deep splice bars had been adopted on some lines, although a straight bar was very generally used, but only 4 bolts are used. As to the bearing surface, that could be obtained by the use of a metal bedplate on the tie, as is done with flange rails on the European continent, thus avoiding the metal of the upper part of the chair, which is necessary with the English track in order to hold the rail up. The wood keys being generally of creosoted and compressed wood, do not give much trouble in England, but in India and other hot countries where the English track has been introduced, they have given considerable trouble. He thought there would not be much difficulty in bolting flange rails down; the heads of the bolts being on top, with fang washers below, the track men could easily keep the track in good condition.

The following candidates were declared elected:

MEMBERS.

W. L. COWLES, King Iron Bridge & Mfg. Co., Cleveland, O.

PAUL DIDIER, Chf. Eng., Pittsburg & Western Ry., Pittsburg, Pa.

H. S. HOLT, Engineer and Contractor, Sherbrooke, Canada.

W. C. KERNOT, Melbourne, Victoria, Australia.

H. K. OWENS, Seattle, Wash. Ty.

A. M. PARKER, Asst. Eng., Dept. of Docks, New York.

A. H. PORTER, King Iron Bridge & Mfg. Co., Cleveland, O.

W. P. RICE, City Engineer, Cleveland, O.

JUNIORS.

S. JOHNSTON, Pittsburg, Pa.; A. S. KIBBE, Albany, N. Y.; W. F. WHITTEMORE, Hoboken, N. J.

Engineers' Club of Philadelphia.—A regular meeting was held March 2; President WM. SELLERS in the chair.

The Secretary presented a communication from Mr. JOHN C. TRAUTWINE, Jr., now in England, containing a description of his journey thither, of the steamship *City of New York*, in which he sailed, the Grand Junction water-works, and the new Tower bridge, London, with illustrations.

Some remarks on points of English, as compared with American, Engineering were made by Messrs. T. CARPENTER SMITH and FREDERIC GRAFF.

The Secretary presented, for Mr. SAMUEL TOBIAS WAGNER, a set of Conventional Signs for Bridge Rivets which Mr. WAGNER referred to as being generally adopted as a standard, and having special merits. There

was some discussion by Mr. HENRY B. SEAMAN, wherein he pointed out what he considered some of the defects of this particular system.

HOWARD MURPHY,
Secretary and Treasurer.

Engineers' Club of Kansas City.—The regular meeting was held March 4. President O. B. GUNN in the chair. On canvas, of ballots, JOHN E. THOMAS, WATERMAN STONE, J. B. CHAPMAN, F. E. PICKELS, E. A. HALPER, R. H. ELLIOTT, and L. B. ROOT were declared elected as members.

Mr. BREITHAUPT reported progress on the question of Bridge Reform. It was found that: (1) Railway bridges are already provided for by the Railway Act, thus leaving the ground free for an act concerning county bridges. (2) The counties are dissatisfied with the present law concerning the letting of county bridges, and would be glad to have a better one. This will give a good starting point to provide for the erection of good bridges. (3) There is great jealousy of any interference with the autonomy of the counties. The bill has accordingly been revised to meet the requirements of the case and returned to the sub-committee to whom it was referred by the Legislature. The Western Society, while endorsing the essential features of the bill, advise no action at present in Illinois.

Mr. C. E. TAYLOR read a paper on "Strengthening Iron Railway Bridges." In bridges considered, trusses found strong enough, while floor and lateral systems were too light for modern traffic. The lightest beam had web ½ in. x 15 ins. and length 14 ft. 6 ins. Bridge panels 15 ft. All beams removed, and replaced by new ones of about 50% greater section, but, with one exception, of same general dimensions as those removed. Owing to the manner in which end beams were connected to truss, it was necessary to disconnect half the lower chord at this point while changing the beams. This was done by relieving chord-bars of tension in two end panels by means of heavy tackle. Changing intermediate beams was somewhat simpler, but required the spreading apart of the bottom of trusses, to disengage beams from posts, in which they were inserted about 6 ft. Another interesting feature of the improvement of these bridges was the changing of several cracked stone pedestal blocks; the corners of the bridges at these points being lifted about 1½ ins. by means of two 20-ton hydraulic jacks and a special bracket attacked to end post.

KENNETH ALLEN, *Secretary.*

Minneapolis Society of Civil Engineers.—At a recent meeting, a paper on the "Panama Canal" was read by Mr. W. W. REDFIELD.

Civil Engineers' Society of St. Paul.—At a recent meeting a paper on "Bridges Over Navigable Streams and the United States Regulations Governing the Same" was read by Mr. POWELL.

New York Railway Club.—The next regular meeting will be held at 113 Liberty St., New York City, on March 21, 1889, at 7.30 P. M. The subject before the meeting will be "The Use of Iron in Freight Car Construction," and a paper will be read by Mr. G. W. ETTENGER, of the Iron Car Co., on the tubular form of iron freight car framing. The enormous consumption of timber and the constantly decreasing source of supply of suitable material of this class for freight car construction, has caused the most progressive of our railroad mechanics to begin to cast about for some substitute. The company which will be represented, and whose form of construction will be advocated, has now in operation over 3,000 cars of 30 tons capacity each. The results of their experience can but prove an interesting matter, and the members of the Club and its friends are cordially invited to be present and take part in the discussion.

C. A. SMITH, *Secretary.*

Ohio Gas Light Association.—The 5th annual meeting, will be held at Mansfield, O., March 20, 21. The following papers will be presented: "The Methods of Taxation of the Different Gas Companies and a Comparison of the Same." H. WILKIEMEYER, Supt. Gas Light Co., Portsmouth, O.

"Fuel Gas and Incandescent Gas Lighting." EDWARD LINDSLEY, Engineer, People's Gas Light Co., Cleveland, O.

"Gas Monopoly." W. W. CANTINE, Secy., Gas Light Co., Alliance, O.

"A Holder-Tank Problem." GEO. H. TAYLOR, Supt. Gas Light Co., Warren, O.

"Oil as a Fuel under Boilers." J. W. GWYNN, Supt. Gas Light & Fuel Co., Bucyrus, O.

"Carburetted Water Gas and its Advantages over Coal Gas." CHAS. R. FABEN, Jr., Supt. Gas Light & Coke Co., Toledo, O.

"The Lowest Price at which Gas can be Profitably Sold in Small Towns." H. L. HURLBURT, Supt. Gas Light Co., Oberlin, O.

"Fuel Gas: Results of Experience in its Manufacture, Distribution, and Use." CHAS. H. EVANS, Manager, Jackson National Gas Light & Fuel Co., Jackson, Mich.

"The Welsbach Burner as a Commercial Article." GEO. W. GRAEFF, Jr., Philadelphia, Pa.

"Advantages of a Combined Coal and Water Gas Plant." GEO. LIGHT, Asst. Supt. Gas Light & Coke Co., Dayton, O.

"Results of the Adoption of Electric Lighting by a Gas Company." L. A. STRONG, President Gas Light Co., Mansfield, O.

"Is the Supply of Natural Gas in the Ohio Valley Failing?" EUGENE PRINTZ, Supt. Gas Light Co., Zanesville, O.

In connection with the meeting there will be an exhibit of gas stoves, engines, burners, electric motors, and all kinds of appliances and apparatus of interest to gas men and the lighting fraternity.

IRVIN BUTTERWORTH, *Secretary.*
Columbus, O.

New England Water-Works Association.—The regular quarterly meeting was held Wednesday, March 13, at Young's hotel, Boston, with 79 present. After the usual dinner a short address was made by the President of the Association, HIRAM NEVONS, Superintendent of the Cambridge Water-Works. A resolution on the death of W. G. BARBOUR, late City Engineer of Cambridge, was offered by A. G. GLOVER, of West Newton, and a letter read from JAS. M. GALE, Chief Engineer of the Water Co., Glasgow, Scotland, expressing his thanks on being elected an honorary member of the Association. The Secretary then read an invitation from J. H. DECKER, Secretary of the American Water-Works Association, to the annual meeting at Louisville, Ky., April 26.

The following members were elected: Resident Active, BYRON J. COOK, Superintendent Woonsocket (R. I.) Water-Works; DWIGHT PORTER, Assistant Professor of Civil Engineering, Massachusetts Institute of Technology; CHAS. H. DAVIS, Water Commissioner, Plymouth. Non-resident, Active member, Capt. L. LUSH, U. S. A. Washington, D. C. Associate members, W. S. SMITH, EVERETT, representing M. H. DINGER, New York City; C. E. ROBERTS, Boston, with Hartford Steam Boiler Inspection & Insurance Co.

EDWIN DARLING extended an invitation to all present to visit the Pawtucket Water-works and inspect a filter in operation there.

CHESTER W. KINGSLEY, of Cambridge, was to have addressed the Association on "The Relation of Great Ponds to our Water Supplies," but being absent, remarks on this subject were made by Mayor JACKSON, of Fall River. These remarks, with discussion, and the experience talks begun at the last meeting, will be given in our next issue.

The Convention of the State Railway Commissions with the Interstate Commerce Commission.

(*Concluded from page 219.*)

Judge COOLEY, Chairman of the Interstate Commerce Commission, opened the meeting with a brief speech which we slightly condense as follows: It gives me great pleasure on behalf of the Commission of which I am a member, to welcome here so many representatives of the several State Railroad Commissions. We are all engaged in a common work. You have, it is true, marked out for you your spheres; and we have our sphere of action that is intended to be as distinct from yours as it is possible in the nature of things that it should be. But I need hardly say to you that if the Union of which we are all members is in itself one and indissoluble, it is even more true that the interests in respect to which we are all officially employed are even more distinctly indissoluble. Indeed, I know of no illustration of diversity and unity more distinct than is afforded by what we are accustomed to speak of as the railway system of this country.

Every railroad in its creation is independent of all others; and if the line is wholly within the limits of a single State, it may be altogether independent in the control that is exercised over it by the public authorities; but it is known to you that there is scarcely a railroad in the United States that, at this time, is so wholly independent that no control reaches it but that of the State in which the line may be situated. The shortest line may possibly afford access to some mine or some particular industry in the product of which the whole country is interested: but if this be not the case, the most insignificant road, the Catskill Mountain road for instance, by reason of its giving coupon tickets to those who have occasion to pass over it, may constitute part of a great highway extending on the west to the Pacific, or on the South to the Gulf of Mexico, so that every man who may buy one of those tickets may be as clearly and directly interested in the management of the road and of the regulation that shall be given to it by the public authorities as if it was in fact and in law a great part of such a great highway.

I mention these things for the purpose of emphasizing the fact, which is of the highest importance, that there should be harmony in the legislation of control, so that this system may be controlled, as nearly as the local conditions of the country will enable it to be controlled, harmoniously and as a unit.

There are two matters of particular importance on which we wished to confer with you: one is the matter of statistics. We are giving a great deal of prominence to the railroad statistics of the country; we are endeavoring to make them as complete as possible. In order that they shall be made complete it is necessary that we should have your co-operation. I think you will be satisfied, when you shall have heard the paper our Statistician will present, that it is of the utmost importance that we should be moving upon the same lines in respect to the railroad statistics of the country; that the legislation in respect to them should be as nearly as possible identical, or at least harmonious; and that we should make sure, when we use the same terms in gathering statistics—terms, for example, like "Through Freight," "Way Freight," and others—that we are using them in the same sense, so that when we gather the statistics and place them before the public, they shall represent actual facts, and therefore have value.

The other matter is the subject of uniform classification. You have all felt, I have no doubt, the annoyance we feel constantly, growing out of the complaints that have their origin in the diversity of classification which prevails in different sections of the country. Now those complaints ought to have their foundation removed as completely as may be found possible. The problem of doing this is a difficult one—so difficult that it is not strange that the most experienced railroad men in the country who have been spoken to upon the subject say at once, "A uniform classification is entirely out of the question; it is absolutely impossible." Now we do not feel that it is so. Our impression has been that the uniform classification was something which could not be effected at once, but which by the co-operation of the several railroad commissions could sometime be accomplished, and would result on the whole beneficially to the country at large.

The Convention then organized by the unanimous election of Judge COOLEY as Chairman: of Mr. MOSELEY, Secretary of the Interstate Commerce Commission, as Secretary; and of Mr. CROCKER of Massachusetts as Vice-Chairman.

A committee appointed on the Order of Business reported, recommending the order suggested in the letter of invitation of the Interstate Commerce Commission, viz:

1. Uniform Railway Statistics. 2. Uniform Classification for Freight. 3. Railway Legislation. 4. Regulation of Railway Construction. 5. Such Other Topics affecting State and Interstate Commerce as may be brought forward by members of the Convention. 6. Heating and Lighting of cars, automatic car-coupling, continuous train brakes, etc. 7. Railway Taxation.

At the afternoon session, Prof. HENRY C. ADAMS, Statistician to the Interstate Commerce Commission, presented a paper on "Uniform Railway Statistics." The advantages arising from the adoption of a uniform basis for the compilation of statistics are of three classes. The first is that it presents the only feasible plan by which accuracy in conclusions may be ensured. This was illustrated by the matter of railway mileage. Mr. ADAMS described the difficulty which his department had met in obtaining accurate statements of mileage from the railway companies, and in avoiding duplications through the joint ownership or operation of a single line by different companies. It is no answer to say that care should be exercised in compiling statistics. What is needed is some proof of the accuracy of the conclusions; some test so that we may know when adequate care has been exercised. The only possible test is to compare results arrived at by different methods or by different persons using the same method. But in order to apply such a test, the statistics must be made up on a uniform basis.

The second advantage in a uniform basis for statistics arises from the fact that the most valuable results are obtained from them when they are made the basis of comparative study. But without uni-

formity in method, no comparison is possible. This point was illustrated by the attempts to obtain the capitalization per mile of road from the different companies.

Finally, uniform statistics are necessary to a complete presentation of facts. The Interstate Commerce Commission cannot obtain and compile certain classes of statistics; but, if they can be collected by the different State Commissions on a uniform basis, they can then be brought together, and the statistics of different States can be compared and totalized. This will result in no less benefit to the State Commissions than to the Interstate Commission.

An examination showed that there was already such an approach to uniformity in the statistics compiled by the Interstate and State Commissions that the move toward greater harmony could easily be made.

The three most necessary requirements for uniformity were stated to be, first a common unit. It was a matter for congratulation that the ton-mile and passenger-mile were now universally adopted in this country. The second requirement was a uniform date for closing the fiscal year: June 30 was recommended. A third need was a uniform classification of oper ting expenses. The classification adopted at the meeting of the State Railway Commissions at Saratoga in 1879 was recommended for universal adoption.

Following Mr. ADAMS' paper, Chairman COOLEY appointed Messrs SPALDING (Ky.), HILL (Va.), SEYMOUR (Conn.), CAPPELLER (O.), PETERSON (Wis.), ADAMS (I. Z. C. C. Statistician), and KIRKMAN (Pres. Amer. Ry. Acc. Off.) a committee to report on the subject of uniform reports and uniform statistics.

Mr. HILL, of Virginia, said that his State was the pioneer in adopting a form for annual reports like that used by the Interstate Commission. Mr. WALKER (Interstate Com.) said that one or two other States had taken similar action to Virginia. He described the difficulties which the Interstate Commission had met in preparing their blank. The present one contained errors and omissions and uncertainties which were not seen till found by experience. After some discussion, the following resolution was adopted:

"*Resolved*, That it is the sense of this Convention that a uniform method of collecting and publishing statistics, both as to time and matter, should be adopted.

The question of uniform classification was then taken up. Mr. BONHAM, for the Missouri Commission, read a brief paper. The classification which was made by legislative enactment in Missouri was found to be inadequate and inequitable; the present system, which permits railways to file their own classification, gives much better satisfaction.

A resolution was read, adopted Feb. 27, by the Board of Trade of Louisville, Ky., declaring the present mixed classifications to be unjust, and asking the Convention to do all in its power to further uniform classification.

Chairman COOLEY, in reply to a question, stated the position of the Interstate Commission. They realized the great difficulties in the way of the adoption of a uniform classification, and also the public demand that it be brought about; therefore they wished to further the movement as fast as could be done without injury to the railways or the business interests of the country.

Commissioner WALKER said the popular demand for uniform classification was especially strong in the West and Northwest. One great obstacle, however, was the fixing of special classifications by law in a few States. Aside from this, the movement toward uniformity is rapid. There are now remaining only the "Official," the "Western," and the "Southern Ry. & Steamship Association's" classifications, and some classifications in use by special roads. The movement to unify these three great classes is now in the hands of a committee, containing representatives from all the chief railway companies of the United States; but their work is necessarily slow. Chairman COOLEY said that he had recently been with the traffic managers of the Northwest, and had found among them a very hopeful feeling with regard to uniform classification. It is now generally felt that its adoption is feasible, an opinion which has not been largely held by railway men till very recently.

It was then agreed that the roll of States be called, and that each member respond with some statement of the classification in force in each. The following was the result: *Alabama*. So. Ry. & Str. Assoc. classification, with a few modifications on the Louisville & Nashville system. *California*. Commission favors uniform classification. *Connecticut* Commissioners have no jurisdiction. *Florida*. Uniform classification required by law. So. Ry. & Str. Assoc. classification, with exceptions, is in force. *Iowa*. Commission strongly favors uniform classification. "Western" is now in force. *Kentucky*. Commission unanimous in favor. *Maine*. Outside of Commission's jurisdiction. *Massachusetts*. No uniform classification in force. Movement toward uniformity regarded as desirable. *Michigan*. Uniformity favored. *Nebraska*. Western classification in force. Commission thinks if uniform classification is reached at all, it will have to be very slowly. *New Hampshire*. Classification left to the railways. Uniformity favored, if practicable. *Pennsylvania*. No opinion expressed. *South Carolina*. State classification in force. Practically is the So. Ry. & Steamship classification with exception sheets. Commission favors unification. *Vermont*. No opinion expressed.

After some further discussion, in which Mr. MASON, of Nebraska, expressed the opinion that any rapid adoption of uniform classification would be absolutely ruinous to the business men of the West, the motion for adjournment was carried.

Wednesday, March 6.

At the morning session the following resolution, presented by Mr. CROCKER, of Massachusetts, was unanimously adopted.

Resolved, That we believe that still further advance towards uniform classification of freight will promote the welfare and convenience of shippers and of the railroad companies, and we commend a conservative but persistent effort to that end.

The next subject taken up was "How to Obtain Harmony in Railway Legislation." Mr. CROCKER said that the subject was one requiring laborious investigation, but that as far as Massachusetts at least was concerned, the laws might certainly be very much simplified and improved. He suggested the appointment of a committee to investigate the subject, and report at the next session. Mr. WOODRUFF thought that the subject was an almost illimitable one. The railroad statutes of Connecticut were a mass with which the best railroad lawyers would wrestle, and reach exactly opposite conclusions. Mr. MASON said Nebraska's railway law was the Interstate law slightly modified and extended, and it worked very well.

The subject was laid aside to hear the report of the Committee on Uniform Statistics. The committee recommended that the fiscal year covered by the railway returns end June 30, and several changes in the headings of the blank for reports. Leave was granted them to continue their work. Mr. BROWN (Penn.) favored Dec. 31 as the end of the fiscal year. Mr. CAPPELLER (Ohio) gave the reasons why June 30 was adopted. It is the fiscal year used by all other departments of the general Government; and the reports made then can be ready for presentation to the Legislatures, which generally hold their session in late fall or early winter. Mr. BONHAM (So. Car.) said that June 30 was adopted at the Saratoga meeting in 1877.

MR. KIRKMAN stated that the railway officers recognized the great importance of a uniform date being chosen, and were willing to waive their own convenience and adopt June 30. The general sentiment seemed to be that June 30 would now be rapidly adopted by the States and railway companies whose fiscal year now ends at other dates, and the report of the committee was adopted.

The subject of harmony in railway legislation was taken up again, and according to vote Chairman COOLEY appointed Messrs. GEO. G. CROCKER, O. P. MASON, H. R. SHORTER, S. E. PINGREE, and J. T. RICH a committee on the subject.

The subject of "Railway Construction, Should Regulation be Provided?" was next on the order, but there was no discussion offered. A historical paper, by SPENCER SMITH, of the Iowa Railroad Commission, on "Railroad Legislation in Iowa," was referred to the Committee on Railway Legislation.

The following motion was adopted:

Resolved, That it is the opinion of the members of this Convention that provision should be made for Annual Conventions of the Railroad Commissioners of the several St rs of the Interstate Commerce Commission, to be held at such place as may be agreed upon, with a view of perfecting uniform legislation and regulation concerning the supervision of railroads.

It was also voted that a committee of three, with the Chairman of the Interstate Commission at its head, should call the next Convention and determine its time and place.

Mr. RICH, of Michigan, brought up the question of interlocking switches and signals at grade crossings. These are in use at about 25 railway grade crossings in that State, and the movement is thought to greatly facilitate the safe running of fast trains. Mr. BONHAM said that in South Carolina the law forbids one railway crossing another at grade. Interlocking switches were not used, as they were too costly.

Mr. WOODRUFF said the law in Connecticut now required new crossings to be over or under. Stops were required at existing grade crossings of railways except when fitted with interlocking devices.

At the afternoon session the following resolutions, offered by Mr. CROCKER, were unanimously adopted:

WHEREAS, Thousands of railroad employés every year are killed or injured in coupling or uncoupling freight cars used in interstate traffic, and in handling the brakes of such cars, and most of these accidents can be avoided by the use of uniform automatic couplers and train brakes; and

WHEREAS, The success and growth of the system of heating cars by steam from the locomotive or other single source, largely depends on the adoption in interstate traffic of a uniform steam coupler; and

WHEREAS, These subjects are believed to be of pressing importance, and within the proper scope of the powers of the Congress of the United States, while attempts on the part of the individual States to deal with them have resulted, and must continue to result, in conflicting regulations.

Resolved, That we do respectfully and earnestly urge the Interstate Commerce Commission to consider what can be done to prevent the loss of life and limb in coupling and uncoupling freight cars used in interstate commerce, and in handling the brakes of such cars, and in what way the growth of the system of heating passenger cars from the locomotive or other single source can be promoted, to the end that said Commission may make recommendations in the premises to the various railroads within its jurisdiction, and make such suggestions as to legislation on said subjects as may seem to it necessary or expedient.

It was then agreed that the Convention should call on the President at 9.30 A. M. the next morning.

By special permission Mr. L. S. COFFIN, Ex-Railroad Commissioner of Iowa, on behalf of the Brotherhood of Railway Brakemen, addressed the Convention on the need of legislation for the adoption of safety brakes and couplers for freight trains.

During the past 10 years accidents in the State of Iowa, due to the use of the link and pin coupler and the hand brake, have killed and maimed 2,424 men, an average of 240 a year. The Commissioners' report shows that there were killed and wounded last year, on the 8,000 miles of railway in Iowa, 349 men by these two causes alone. On this basis, at least 6,000 men must have suffered death or injury from these causes in 1888. In all the great accidents of the past 50 years, there have been less killed and maimed than were killed and maimed from these two causes last year. Every hour of the day three or four of these strong, vigorous young men are wounded or killed. The only legislation needed is in regard to couplers and brakes. Car heating will take care of itself now, for as a matter of advertisement every main line will have safety heating apparatus. Last year in Iowa 29,435,846 passengers were carried, and not one was killed or burned by a car stove; but during the same time 349 trainmen were killed or injured from causes which automatic couplers and brakes would remedy. The order of railway brakemen has about 15,000 members, which is about one-sixth of the number in the whole United States, and it pays out $20,000 monthly to injured members. These brakemen are poorly paid; but out of their wages they have to contribute thus heavily to support those of their number who are injured.

There is not now one particle of excuse for delay in compelling transportation companies to adopt these safety appliances. As far as dollars and cents are concerned, it is cheaper. Mr. RHODES, the master of motive power of the Chicago, Burlington & Quincy, says that it takes from three to four dollars annually to keep in repair the old common link and pin coupler. It costs but $24 to equip a car with a safety appliance, and after three or four years it be-

comes a paying concern, because it costs less to keep it in repair than it does to keep in repair the common draw-bar coupler.

All the subjects that have come before this conference sink into insignificance beside the great and terrible fact that six thousand and upward of these strong and active men are either crushed under the wheels of the car or maimed for life on account of the causes named.

The Convention then adjourned.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Cleveland, Columbus, Cincinnati & Indianapolis.—The annual meeting of this company was held at Cleveland, O., March 6. The gross earnings of the company were $7,611,000, a decrease of nearly half a million dollars over 1887. At the directors' meeting the President was authorized to appoint a committee to confer with a committee from the Cincinnati, Indianapolis, St. Louis & Chicago company with regard to the terms of a consolidation of the two properties.

It is stated that the VANDERBILTS have secured about 15,000 shares of "Big Four" stock. The organization of the two companies will probably be little changed, but they will be operated in harmony.

It is reported that the Cairo, Vincennes & Chicago, extending from Cairo to Danville, Ill., 261 miles, is to form part of the new combination; and that the Cleveland, St. Louis & Kansas City road, under construction from Alton, Ill., to St. Louis and Kansas City, will also be included. This would make the total extent of the new system about 1,400 miles.

Delaware & Hudson Canal Co.—Chief Engineer A. J. SWIFT recently made a reconnoissance for the proposed extension from Port Kent to Keeseville, N. Y., about four miles.

Chesapeake & Ohio.—A new depot for suburban passenger traffic will be built in Cincinnati on Fourth Street.

Canadian Pacific.—It is announced that the new Short Line route across the State of Maine will be opened by May 15 for through passenger trains between St. John, N. B., and Montreal.

Quebec Central.—The Provincial Government of Quebec has granted a subsidy of $2,250 and 2250 acres of land per mile for an extension of 52 miles from St. Francis to the Maine boundary to connect with the Canadian Pacific system.

Lake Erie, Essex & Detroit River.—Work is to begin very soon on the extension to Leamington, Ont. Strong inducements are offered the company to extend the line to Blenheim, where connection would be made with the Erie & Huron Ry.

Canada & St. Louis.—THOS. A. STARR has been appointed Receiver of the Indiana division. The Michigan divisions, known as the Battle Creek & Bay City and the Battle Creek & Sturgis railroads, have been placed in the hands of W. A. ACKERMAN, of Chicago.

Cornwall & Lebanon.—According to the *Railway World*, President ROBERT H. COLEMAN has not given up the proposed extension to Reading, Pa., as has been reported, but will start work on it by May 1.

Wilkesbarre & Western.—It is reported that this Pennsylvania road will be finished as originally projected by the construction of an 18-mile extension from Millville to Shickshinny. The extension is believed to be in the interest of the Lehigh Valley.

Grand Rapids & Indiana.—The annual report of this company shows total gross earnings from 557.65 miles of railways operated of $2,842,363, a decrease from 1887 of $111,591. Operating expenses were $1,988,635, practically the same as last year.

Cincinnati, Wabash & Michigan.—It is rumored that a line is to be built from Milford, Ind., at the junction of this road with the Baltimore & Ohio, via Goshen and South Bend, to St. Joseph, on Lake Michigan.

Projects and Surveys.

Addyston & Ohio River.—A charter has been granted to W. P. ANDERSON, B. S. CUNNINGHAM, J. N. KING, and others, of Cincinnati, O., to build a line of railway from Cincinnati to North Bend, a distance of about 15 miles, with a branch from the main line in Miami township to a point on the Ohio river south of Addyston. The general offices of the company will be at Addyston, O.

State Line & Oakland.—G. W. HOWLENBECK, G. D. JOHNSTON, HERBERT B. PRESTON, and E. J. SILKMAN have incorporated this company, which proposes to build a road from Oakland, Md., to Confluence, Pa., about 45 miles. The same parties with others have also incorporated the Yough-Manor Land Co. to develop the timber and mineral lands along the route of the road, which is now under survey.

Niagara Falls & Whirlpool.—At a recent meeting of the directors of this company the following officers were chosen: D. W. FENTON, President; BENJ. FENTON, of Buffalo, N. Y., Vice-President; S. FENTON, Jr., of Brooklyn, N. Y., Treasurer; ALEX. WHITE, Secretary; and MORRIS MOREY, Attorney. This company was organized three years ago to build a railway to the Niagara Whirlpool, but has so far been unable to secure the necessary right of way. It is stated that the company will this year make renewed efforts to obtain the right of way and construct the line.

Schuylkill & Lehigh.—It is reported that contracts for the construction of several portions of this Pennsylvania road have been let. EATON N. FRISBIE, No. 1 Broadway, New York, is President of the company.

Tiffin & Fremont.—We have received the following information from T. G. KANEY, of Toledo, Ohio, Chief Engineer:

The surveys for this road have been finished from Marblehead via Fremont and Tiffin to Upper Sandusky, a distance of 65 miles, and engineers were put in the field March 7, to locate the remainder of the route. The terminus of the road will probably be a point on the Ohio river near Wheeling, W. Va. The work will be light and grades easy; the maximum curve will be 5°. The greater part of the right of way has been obtained. It is expected to complete the road to Fremont by the first of June. The company was incorporated in October, 1883. J. O. SLOAN is President.

SOUTHERN—Existing Roads.

Norfolk & Western.—A correspondent sends us the following concerning the Clinch Valley extension:

Orders have been given to push the work. Track is now laid over Sexton's and Houston's divisions. Henry Davies, who has the next division, expects to finish grading in two months. This will permit the trackiayers to reach Cedar Bluff, 30 miles west of Graham, by July 1. McGraw & Stewart are making good progress on the 1,050 ft. tunnel at Hinaker. About 270 ft. remains to be driven. The Cumberland Gap tunnel, on the L. & N. line, is open 1,150 ft. on the Tennessee side, and 1,050 ft. on the Kentucky side, with 1,590 ft. yet to drive.

A survey for the proposed extension to Mt. Airy, N. C., is reported in progress:

Alma & Little Rock.—The name of this North Carolina road is to be changed to the Maxton, Alma & Rowland Railroad. Arrangements are nearly completed for the extension to Maxton.

Louisville & Nashville.—J. W. Worthington & Co., of Birmingham, have the contract for a 4-mile branch to the mines of the Southern Mining Co., and also for the Red Gap extension. It is stated that work will soon begin on the extension of the Mud River branch of the Owensboro & Nashville from the present terminus to Rochester, Butler county, Ky., about 12 miles.

Charleston & Savannah.—The annual report of this company, a part of the Plant system, shows the following results of operations:

	1887.	1888.	Increase.
Gross earnings	$481,411	$539,732	$58,320
Operating expenses	398,801	446,658	47,856
Surplus	82,610	93,074	10,464

Several improvements are recommended by General Manager HAINES, but none are of large amount.

Louisville, St. Louis & Texas.—The new bridge at Spottsville, Ky., has been completed, and through trains are now running between Louisville and Henderson. Four acres of land have been purchased at Henderson, and shops will be erected there.

Charleston, Cincinnati & Chicago.—It is now stated that this company intends to build an independent line from Camden to Charleston, S. C., instead of using the South Carolina Railroad. If it does this, it will doubtless secure a much more direct line than the South Carolina road.

Central Railroad of Georgia.—Track will be laid at once on the 7 miles graded last fall, on the proposed Savannah & Western Railroad from Eden west.—It is stated that the Augusta, Gibson & Sandersville and the Sandersville & Tennille roads will soon be leased to this company.

Apopka & Clay Springs.—This short Florida railroad is under construction by the Pierce & Torry Co. of Orlando. R. C. Waters, of Apoka, has the contract for grading.

Savannah & Tybee.—Receiver H. MYERS has let the contract to Martin Cooley for completing this road.

Tennessee Midland.—The extension from Jackson, Tenn., east, has been opened for business as far as Lexington, 26 miles.—At a recent meeting of the directors it was voted to postpone letting the contracts for the extension from the Tennessee river to Nashville until the funds necessary to complete the road are secured.—It is reported that the ground has been broken in Montgomery county Va., for the Viginia Western division.

Winston & Mocksville.—Col. A. B. ANDREWS of Mocksville has been elected President of this North Carolina company. The directors have voted to continue the road from Mocksville south to Statesville or Mooresville. About 135 convicts are at work, and it is expected to have the road graded to the Yadkin river by June 1.

Illinois Central.—It is rumored that the proposed branch to Vicksburg, Miss., chartered many months ago as the Vicksburg & Canton Railway and located ready for construction, will be taken up by the company. It is also reported that a branch will be built from Yazoo City to Greenville, about 52 miles.

Lexington Terminal.—This Georgia company wishes to purchase locomotive, rails, etc., to equip its 3-mile road. HAMILTON MCWHORTER, of Lexington, Ga., is President.

Silver Springs, Ocala & Gulf. It is rumored that this Florida company contemplates an extension from Silver Springs, northeast to Palatka, about 50 miles.

Florence Northern.—Mr. A. G. NEGLEY, Jr., Asst. Secretary of this company, writes us as follows from Florence, Ala., under date of March 12:

Work on the Florence Northern is progressing rapidly. Neeley, Smith & Co., the contractors of the road, are pushing the work as fast as possible, having completed in the last 30 days, 6 miles ready for the ties and rails. Work is opened up on the first 25 miles north of Florence, and if the weather permits, this will be ready for the ties and track within 60 days.

Tracklaying will begin at Florence about May 1, 1889, and trains will be running to the great iron ore fields of Wayne county, Tenn., not later than July 1, 1889. This will give the two furnaces at Florence, and three at Sheffield, just opposite Florence, the opportunity of starting; they have been lying idle for the want of iron ore. The Florence Northern will receive the bulk of the traffic from these five furnaces. It will be laid with 56-lb. steel rails on cross ties of the best white oak, and will have first-class equipment throughout. The locating party of the engineer corps left to-day to finish the location of the line from the 25-mile post to its connection with the Tennessee Midland Railroad at or near Linden, Tennessee.

Projects and Surveys.

Rutledge & Julian.—Incorporated in Alabama to build a railway from a point on the Northwest & Florida, near Julian Station, to Rutledge, Crenshaw county. The principal offices will be at Rutledge.

Etowah Valley.—It is stated that an effort is being made to reorganize this Georgia company. The road was originally intended to be a branch of the Gainesville & Dahlonega R. R. and would connect with it at Cartersville.

Beaman's Lake & Knoxville.—A company has been organized in Tennessee to build a dummy railway from Beaman's Lake to Knoxville. Hon. J. C. J. WILLIAMS, of Knoxville, Tenn., is interested.

Scotland Neck & Ringwood.—Organized in North Carolina to build a narrow-gauge railway from Scotland Neck to Ringwood, a distance of 15 miles.

Louisville, Hardinsburg & Western.—The locating surveys of this Kentucky road have begun at Irvington; and it is expected that work on construction will begin soon. The road was projected to run from Irvington via Hardinsburg to the Falls of Rough river. J. C. FAWCETT, of Louisville, is President.

Selma, Bessemer & Pensacola.—The city of Selma, Ala., has subscribed $100,000 toward the building of this road from Selma to Birmingham, a distance of about 83 miles. It is expected that the contract will be awarded and construction begun inside of 60 days.

Stevenson Coal.—A project is on foot to build a railway from Stevenson, Ala., to the coal lands on Sand Mountain. The Stevenson Land & Improvement Co. is interested.

Meridian & Tuscahoma.—It is stated that the survey for this narrow-gauge road between Meridian and Tuscahoma has been finished.

Wilmington, Onslow & East Carolina.—The franchise of this North Carolina road has been sold to THOS. A. MCINTYRE, of New York, and a syndicate of Northern capitalists: and is stated that the road will constructed and equipped within six months.

West Virginia & Pennsylvania.—Incorporated in West Virginia to build a railway from Rowlesburg, Preston county, to the Pennsylvania State line, by GEO. W. L. MARSDON, of Philadelphia, and W. M. DAWSON, B. M. SQUIRES and others, of Preston county, W. Va. The headquarters of the company will be at Kingwood, W. Va.

THE NORTHWEST—Existing Roads.

Chicago & Eastern Illinois.—The projected extension from Tuscola, Ill., to East St. Louis is said to be decided upon, and it is reported that rails for the extension have already been purchased.

Pennsylvania.—A report is in circulation that the Cairo, Vincennes & Chicago is to become part of this system; but the report seems to come from no authentic source. Another story, which seems even more improbable, is the statement that the Pennsylvania is to purchase the Chicago, Santa Fé & California railway.

Belleville, Centralia & Eastern.—At a recent meeting of the directors of this Illinois company it was voted to consolidate with the Louisville, Evansville & St Louis and the Illinois & St. Louis companies. Work on the 60 mile extension from Belleville to Mt. Vernon is to begin soon.

Northern Pacific & Manitoba.—Track has been laid on the Portage la Prairie extension to a point 31 miles west of Winnipeg, and work has stopped there for the present.

Duluth, Red Wing & Southern.—Track is to be laid on the unfinished portion of this Minnesota road between Red Wing and Zumbrota as soon as spring opens.

Duluth & Winnipeg.—Contractor M. H. Foley expects to resume work on this road in a few days, and will probably have 1,000 hands on the line by April 10. The locating surveys are completed as far west as the Mississippi river and the line will be pushed west from there to some point in the Red River valley. The maximum grade between Cloquet and the Mississippi is 15 ft. per mile.

Great Northwest Central.—It is reported that this road, now being built from Brandon, Man., west, will connect with a proposed road to be built from Vancouver

east through the Yellow Head pass; and that the whole line when completed will form part of the Northern Pacific system. If the scheme is ever carried out, it will probably be in the very remote future.

Projects and Surveys.

Hermosa, Hill City & Western.—It is stated that the surveys have been made for this road, which is projected to run from Hermosa, Dak., to the Wyoming boundary line west from Hill City, Dak., a distance of 65 miles. The directors are MILTON R. MAXSON, ALVIN S. WAY, J. W. STREETER, THOS. L. MONAGHAN and C. J. PATTON, all of Hermosa.

Berlin & Green Lake.—This company has been chartered in Wisconsin to build a railway from Berlin to Ripon, about 13 miles. GEO. B. JACKETT, W. H. JOHNSON, R. A. CHRISTIE, and others, of Berlin, are the incorporators.

Duluth, Crookston & Northern.—This company, noted in our issue of March 2, has been incorporated in Minnesota to build a line of railway from a point on Lake Superior near Duluth, northwest through Crookston to a point on the northern boundary line of Kittson county, with branches from Crookston west to the Red river, and from Crookston southeast to Brainerd. Among the incorporators are ROBERT J. MONTAGUE, EDMUND M. WALSH, and JOHN LOCKEN. The principal offices will be at Crookston.

Electric City & Illinois.—Incorporated in Illinois to build a line of railway from the eastern approach of the Merchants Bridge to be constructed at St. Louis, to East St. Louis. Among the incorporators are CHARLES D. MCLURE, C. C. RAINWATER, and JOHN WHITTAKER, of St. Louis.

THE SOUTHWEST—Existing Roads.

Houston, Central Arkansas & Northern.—The contract for the construction of this road from Pine Bluff, Ark., to Alexandria, La., has been let to the Reynolds & Henry Construction Co. The first 50 miles will be completed by June 15, and 100 miles more will be put under contract some time in May.

Omaha, Dodge City & Southern.—A contract has been let for the construction of this road from Dodge City, Kan., to Superior, Neb., a distance of 203 miles. The road is to be completed and in operation on or before Dec. 1, 1889. J. W. SUMMERS, of Keokuk, Ia., is the contractor.

Kansas City, Fort Smith & Southern.—Work is in progress on this line from Neosho, Mo., south to Fort Smith, Ark., a distance of 105 miles.

Chicago, Kansas & Texas.—The preliminary survey has been completed from Kansas City north about 30 miles, and of this 10 miles has been located, and the contract for its construction has been let to Creech, Lee & Kenefick, of Kansas City, Mo.

Red River, Sabine & Western.—LL. W. LLOYD, of Nacogdoches, Tex., President of this company, writes us as follows:

This road is to run from Fort Worth, Tex., via Corsicana, Fairfield, Palestine, Nacogdoches, and San Augustine to Alexandria, La., a distance of 345 miles. A preliminary survey has been run over 40 miles of this route and 17 miles have been located. The route is favorable, running through a fine agricultural region and a country rich in pine timber, mineral oil and iron ore. The principal business will be the transportation of timber, cotton, sugar and iron ore. About 40 miles of the right of way has been secured and other local aid to the amount of $55,000 obtained. The contract for construction has been let to the Fort Worth Construction Co. Track laying will begin in about 30 days and a portion of the road will be open for traffic in 4 months. The company was incorporated Dec. 14, 1888. J. C. TERRY is Chief Engineer.

Texas & Pacific.—The annual report of company shows better results than were expected for the operations of 1888.

Gross earnings	$6,374,386
Operating expenses and taxes	5,071,669
Net earnings	1,302,717

A new board of directors has been elected, consisting almost wholly of representatives of the Missouri Pacific interests.

Missouri Pacific.—The annual report of this company shows the following earnings and expenditures for 1888:

Gross earnings	$13,330,017
Operating expenses, interest, etc.	12,889,221
Surplus	430,796

St. Louis & San Francisco.—It is stated that this company will build a line of railway from Salem, Mo., to Little Rock, Ark., during the present season. The bill which was passed by Congress, granting the company right of way from a point on the Arkansas State line in Hurton county through the Indian Nation, to Texakana and from Kosomra in the Choctaw Nation, to Denison, Tex., failed to receive the signature of the outgoing President, and thus did not become a law.

Grand Isle.—It is stated that H. C. WARMOTH is making a survey with the view of running the Grand Isle Ry. of Louisiana, through Jefferson parish.

Projects and Surveys.

Hutchinson, Oklahoma & Gulf.—Incorporated in Kansas to build a line of railway from Beloit, Kan., south through Oklahoma, the Indian Territory, and Texas to some point on the Gulf of Mexico, a distance of about 500 miles. Among the incorporators are A. L. WILLIAMS, of Topeka; EDWIN E. WISE, of Chicago; WM. T. PINCHART, of Pittsbugh, Pa.; A. W. LEE, of Hutchinson Kan. and JAS. T. PURCELL, of Boston, Mass.

Topeka, Westmoreland & Marysville.—A charter has been granted to JOHN R. MULVANE, of Topeka; J W. FITZGERALD, of St. Mary's; A. B. POMEROY, of Westmoreland, and others to build a railway from Topeka Kan., through the countries of Shawnee, and Pottawatomie to the north line of Marshall county, a distance of about 100 miles.

St. Charles & Helena.—It is stated that the engineers are now making the locating survey of the proposed route, and will complete their work in about 45 days The road is to run from St. Charles, Ark., to Helena, Ark., about 30 miles. W. H. BRADFORD is President, and JOHN SHINN is Secretary.

Lampasas, Burnet & Southwestern.—Incorporated in Texas to build a railway from Lampasas through the county of Burnet to a point on the Austin & Northwestern R. R., in Burnet county, a distance of about 30 miles.

New Orleans, Natchez & Fort Scott.—A press report states that grading has at last begun on this road at Natchez, Miss., and that it is to be completed from Natchez to the Arkansas line by Jan. 1, 1890. JAS. N. YOUNG, L. D. LATHAM, and others of Chicago are interested. E. B. WINGATE is Chief Engineer.

ROCKY MT. AND PAC.—Existing Roads.

Santa Fé Southern.—This company, recently incorporated in New Mexico Ter., has absorbed the Texas Santa Fé & Northern R. R., succeeding to all the rights and franchises of that road, which runs from Santa Fé to Espanola, about 40 miles. It is stated that an extension of the road from Santa Fé is under consideration.

Spokane Falls & Northern.—Contracts for the grading and timber work on the first 80 miles of this road have been let to Spokane Falls parties. Contracts for tracklaying will be let later. The road is to be completed to Colville by September first, and pushed on to Little Dalles, on the Columbia river, this season, if possible. E. J. ROBERTS, of Spokane Falls, is Chief Engineer.

Fairhaven & Southern.—It is stated that contracts have been let for the construction of this road, which is to run from a point on Bellingham Bay about 2 miles south of Whatcom, W. Ter., to a point on the Skagit river, a distance of 30 miles. The following are the officers of the company: NELSON BENNETT, President, E. M. WILSON, Vice President, both of Tacoma, and E. L. COWGILL, Secretary and General Manager, with offices at Fairhaven, W. Ter.

Union Pacific.—It is stated that this company has under consideration the consolidation of its Utah lines under one corporation. Articles of consolidation have already been drawn up between the Oregon Short Line and the Utah & Northern, operating 1,051 miles of road; and should the other four companies come in, 1,436 miles of road would be operated by one company instead of four. The contest for the possession of Jefferson cañon between the employés of this road and those of the Northern Pacific, about which the papers have said so much, proves to be of small import and to have resulted from the superfluous zeal of subordinate officials.—Surveyors are at work on the Big Horn Southern, which is to run from a point where the Cheyenne & Northern enters Montana through the Crow Indian reservation. It is stated that the company has under consideration the construction of a branch from the main line to Lake Manawa, near Omaha, Neb., a distance of about 5 miles.

Oregon Railway & Navigation Co.—It is stated that Chief Engineer W. H. KENNEDY has commenced the preliminary survey of this company's proposed branch from La Grande, W. Ter., to Walla Walla, W. Ter.

Oregon & Washington Territory.—A favorable route has been found for the proposed branch to Whetstone Hollow, a distance of 45 miles. The maximum grade is 85 ft. per mile and maximum curve 10°. There will be several trestles ranging from 40 to 80 ft. in height. It is probable that work will be commenced soon.

Vancouver, Klickitat & Yakima.—Grading is completed on the second 5-mile section of this road and tracklaying will begin soon. It is expected to have the road finished to Salmon Creek within 2 weeks.

San Diego & Ocean Beach.—It is stated the property of this company and the franchises of the San Diego & Delmar R. R. Co. have been sold to Eastern parties who will complete the road to Delmar, about 20 miles, within six months.

Salt Lake, Nevada & California.—Contracts are reported closed for grading the first 20 miles of this road west from Salt Lake City.

Denver & Rio Grande Western.—New steel has just been purchased for relaying the line, which will be done as fast as the change to standard gauge is effected. This work will be carried out during the coming season.

Projects and Surveys.

Santa Ana & Long Beach.—M. J. BUNDY, of Santa Ana, Cal., President of this company has sent us the following information:

The surveys are nearly completed for this road, which will run from Santa Ana via Westminster to Long Beach, Cal., a distance of 20 miles. The work is generally light. There will be one large bridge. The greater part of the right of way has been promised. We expect to let the contracts for construction during the present season. The company was incorporated Oct. 31, 1888. Captain HEALY, of Long Beach, is Chief Engineer.

Port Townsend Southern.—Contracts will be let on March 23, for constructing 6 miles of this Washington Territory road. The offices of the company are at Port Townsend. J. A. KUHN is President and J. B. HOGG is Chief Engineer.

Portland, Seattle & Northern.—Incorporated in Washington Territory to build the following railroads: From a point near Seattle, W. Ter., south to point near Portland, Ore., about 165 miles; from Seattle, W. Ter., north via Whatcom, W. Ter., to a point on the northern boundary near the town of Blaine, a distance of 100 miles; from the point where the last named line crosses the Skagit River to Spokane Falls, a distance of 300 miles; from the point where the first above described road crosses the Skagit River, west to Adversity Head on Whitby Island, about 35 miles. Among the incorporators are ELIJAH SMITH, JAMES BENEDICT, J. S. STANLEY, and JOHN P. HOYT.

Watsonville & Moss Landing.—A project is on foot to build a narrow gauge railway from Watsonville, Cal., to Moss Landing, Cal.

Goldendale & Eastern.—A company by this name has recently been organized in Washington Territory. D. W. PIERCE, C. S. REINHART, R. O. DUNBAR and others of Goldendale, W. Ter., are interested.

Ellensburg, Big Bend & Okanogan.—It is stated that the prospects are good for the early construction of this Washington Territory road.

FOREIGN.

Sonora, Sinaloa & Chihuahua.—According to numerous press dispatches, this railway is to run from Deming, N. M., to Guerro, Mexico, 600 miles, with branches from that point to Guaymas and Chihuahua. Among the parties who are pushing the project is Lieut. FREDERICK SCHWATKA, the Arctic explorer. Clark & Son, of Chicago, have taken a contract for the construction. Major SISSON is the Chief Engineer.

The project has been a long time in the preparatory stage, and the little we have been able to learn of it has not tended to increase faith in the probability of its construction.

Monterey & Mexican Gulf.—Tracklaying has been in progress for about a month on this Mexican road and part of the rolling stock has been received.

Texas Topolobampo & Pacific.—It is stated that Richards, Clegg & Co., of Dayton, O., have taken the contract to build a railway from Guaymas to Topolobampo bay, 240 miles, the work to be finished by April 16, 1891.

Mexican National Construction Co.—It is stated that a line is to be built from some point on the Northern division via Zacatecas, Guadalajara, and Colima to Port Manzanillo. Work in the state of Colima has already begun.

Interoceanic of Mexico.—Reed, Campbell & Co. have 2,000 men at work on the grading and will soon increase this to 10,000. Five parties of engineers are now completing the location to Vera Cruz. It is expected to have the line from the City of Mexico to Peroti open this month. The same firm are also at work on the surveys for the Tehuantepec railway, and contracts for its construction will be let in about six months.

RAPID TRANSIT.

Elevated Railways.—***Brooklyn, N. Y.***—The Pencoyd Iron Co. has the contract for the Fifth Ave. line.

Kansas City, Mo.—A franchise for an elevated road has been applied for by D. E. CORNELL and others.

Dallas, Tex.—The contract for the elevated line to West Dallas has been let, and the work will be completed in about 3 months. The line will be 3 miles long and will cross the Trinity river.

Cable Railways.—***Providence, R. I.***—The Cable Tramway Co. will apply for an amendment of its charter to enable it to extend its lines into the town of Johnston.

Brooklyn, N. Y.—The Brooklyn City Ry. Co. is reported as intending to build a cable line from Fulton Ferry to Fort Hamilton.

Chicago, Ill.—Contracts have been let for the cable work on the West Side lines. The Pennsylvania Iron Works, of Reading, Pa., will build the Madison St. power station; Fraser & Chalmers, of Chicago, will build the Milwaukee Ave. power station; Robert Wetherill & Co., of Chester, Pa., will build the cable driving plant; the Bullock Mfg. Co. will supply the machinery for the Milwaukee Ave. line; Wright, Meysenburg & Co., of St. Louis, will construct the Milwaukee Ave. line, and will sublet the contract for 4,000 tons of castings.

Denver, Col.—Christie & O'Day, the contractors for the lines of the Denver City Cable Ry. Co., have commenced work. The Kansas City Switch & Frog Co. has the contract for switches, crossings, etc., for about $20,000. The Denver Cable Tramway Co. is extending its lines.

Tacoma, Wash. Ty.—The VILLARD & OAKES syndicate has acquired entire control of Mr. NELSON BENNETT's street railway, and will begin work at once on the first cable line.

Seattle, Wash. Ty.—The Front St. Cable Ry. Co. has its cable laid. The road has cost nearly $350,000.

San Francisco, Cal.—The Cliff House & Ferries Ry. Co. has received the following bids for its new engines: Reliance Machine Works, $18,154; Miners' Iron Works, $18,750; W. T. Garratt, $19,000; Risdon Iron Works, $19,450; Union Iron Works, $19,500; Vulcan Iron Works, $21,600; Fulton Iron Works, $23,000. The Omnibus Ry. Co. is building its Post St. cable line.

Waco, Tex.—The Waco Street Ry. Co. proposes to adopt a cable system.

Electric Railways.—***Newton, Mass.***—The Newton Street Ry. Co. has decided to adopt the Thomson-Houston electric system. Some people wanted a storage battery system.

Salem, Mass.—The Naumkeag Street Ry. Co. is preparing to operate its lines by electricity. The cost of equipment is estimated at about $100,000.

Southington, Conn.—The Southington & Plantsville Electric Tramway Co. has its electric line in operation. The road is one mile long, nearly level, and has the overhead system. There are two cars.

Port Jefferson, N. Y.—An electric railway to Patchogue has been projected.

Chattanooga, Tenn.—The Chattanooga Electric Ry. Co., which is to build a line to the Chickamauga battlefield, has bonded the road for $250,000 to the Union Trust Co., of Philadelphia, and will commence work at once.

Richmond, Ind.—A franchise for an electric system on the present horse-car lines has been granted to J. C. SHAFFER, of Indianapolis.

Detroit, Mich.—A trial of the storage battery car, for which the Woodward Electrical Co. has the patents, has been made on the Highland Park line.

St. Joseph, Mo.—The South Park Ry. Co. has been incorporated to build an electric line in the south part of the city. Among the directors are JOSEPH HANSON, J. D. MCNULTY, and J. C. MADINGER.

St. Louis, Mo.—The Electric Railway Co. has been granted a franchise for an elevated electric line; the columns will be 40 ft. apart. The company is to pay the city $5,000 on the acceptance of the franchise, and the fare is to be 5 cts. Among the incorporators are S. J FISHER, MAURICE PRENDEVILLE, and D. S. BENTLEY.

Olympia, Wash. Ty.—Work on the electric line will be commenced shortly.

Red Bluff, Cal.—An electric railway is projected. Power will be supplied from the electric light works.

Street Railways.—***Middletown, N. Y.***—A street railway is projected, and negotiations are in progress.

Roanoke, Va.—The Roanoke Street Ry. Co. is purchasing material and will begin work early in April. Steam or electricity may be adopted.

Orangeburg, S. C.—A franchise for a street railway has been granted to a local company, with a capital stock of $25,000.

Pine Bluff, Ark.—The Citizens' Street Ry. Co. will extend its line a mile or more; the present road is 3¼ miles long, nearly level, with a 35-lb. rail; standard gauge. During the summer it is proposed to experiment with some mechanical traction system other than cable or electricity. Correspondence is desired with parties controlling such systems or motors.

Salt Lake City, Utah.—A franchise has been granted to the City Railway Co., which will build 5 miles of line at once.

Albany, Ore.—The Albany Street Ry. Co. has been granted a franchise, and will begin construction at once.

San Bernardino, Cal.—The San Bernardino & Colton Street Ry. Co. will experiment with a gas motor; if successful, it will be used on the Riverside and Arlington line.

Dummy Line.—***Atlanta, Ga.***—The North Atlanta Dummy Line Co. has been organized by W. S. THOMSON, J. R. GRAMLING, A. M. REINHARDT and others. The capital stock will be about $50,000.

CONTRACTING.

New Croton Aqueduct.—The only proposal received by the Aqueduct Commissioners, New York City, for roof, doors, windows, etc., at the Ardsley gate-house on Section No. 7, was from Coldwell, Wilcox Co., for $3,165.

Barges.—The following proposals for 30 wooden barges were opened Feb. 23 by Captain C. F. POWELL, U. S. Engineer: Don Carlos Robinson, Madison, Ind., $3,175 each for 6; Cincinnati Dry Dock Co., Cincinnati, O., $3,350 each for 6; J. H. Gardner, New Orleans, La., $4,500 each for 6; Pointevant & Favre Lumber Co., Pearlington, Miss., $4,500 each for 6; E. J. Howard, Jeffersonville, Ind., $3,300 each for 6, $3,190 each for 12, $3,180 each for 18; Ripley Mill & Lumber Co., Ripley, O., $3,250 each for 6, $3,225 each for 12; Henry Mack, Cincinnati, O., $3,100 each for 6 or 12.

Excavation.—Wright & Wallace, of Lafayette, Ind., contractors, for dredging, ditching, etc., write us correcting the figures on p. 178. The ditch is 30 ft. wide and 10 to 18 ft. deep; the price is 10¾ cts. per cu. yd. The work is for the Consolidated Coal Co., of St. Louis, and the following particulars are furnished by Mr. A. F. BUNKER, Superintendent of Mines, Wabash Ry., of Danville, Ill. The location of the work is 8 miles west of Danville, on the line of the Ohio, Indiana & Western Ry. The purpose is to strip off the dirt and then to take out the underlying stratum of coal, which is about 5 ft. in thickness. The material to be taken off, excavated or removed, is of a gravelly nature, from about 10 to 18 ft. in thickness, and about 1½ ft. of soap-stone. This ditch will be cleaned of everything covering the coal, removing all the dirt to one side. It is then proposed to take out the coal, and as fast as it is taken out, the contractors will start on the side where the dirt is not piled, and uncover another place of the same width and length, depositing the dirt from the second excavation in the place made by first excavation and so on, repeating the process. They will be ready to begin loading coal by July 1, and expect to load about 2,000 tons per day.

Street Work.—***East Liverpool, O.***—The following proposals for grading, gravel, sand and paving have been received by W. H. GRIGGS, City Clerk: G. B. Borm, Steubenville, O., 99 cts. per sq. yd.; Nicholson & Bates Steubenville, O., $1.02; C. H. Connel, Youngstown, O., $1.26; Jas. M. Todd, Wheeling, W. Va., $1.26; Ridley & Gribben, $1.45.

Gladstone, Mich.—The following proposals for wood paving were received March 1 by W. BUCHANAN, Chairman of the Street Committee: J. F. Collum, Minneapolis, Minn., $9,572.44; A. Tiedemann, Ludington, Mich., $10,562.95; Thornton & Shaw, St. Paul, Minn., $10,909.09 The contract was awarded to J. F. Collum.

Brooklyn, N. Y.—The contract for grading 1st Ave., at Bay Ridge, has been let to John Curran at $28,450. The other bidders were, Thomas R. McCann, $28,843; Theodore S. Jenkins, $32,307; Charles Hart, $42,500; J. J. Morrissey, $43,000.

Gravel.—At Newport, R. I., the following bids were received by the Street Committee for paving gravel for the present year: J. Harrington, 49 cts. per ton; B. F. Webb, of Rigglesville, Me., 58 cts.; Dennis Mahon, 55 cts.; E. O. Riggs, 63 cts.; J. T. Kaul, 80 cts.; H. Washington & D. Connolly, 79 cts.; J. S. Anthony, 83 cts. The contract was awarded to T. Harrington.

Cement.—The following proposals for Portland cement have been received by the Docks Commissioners, New York City: Emil Lenz, $2.28 per bl., slow-setting; S. L. Merchant & Co., $2.31, slow-setting; A. C. Babson, $2.37; James Brand, $2.40, quick-setting; Empire Warehouse Co., $2.45, quick-setting; E. W. Fisher, $2.45, quick-setting; Eckmeyer & Co., $2.75. The contract was awarded to James Brand, the lowest bidder for quick-setting cement.

Sewers.—***New Haven, Conn.***—The following proposals have been received by A. B. HILL, City Engineer, for the construction of sewers in three districts of the city:—No. 1: A. Brazos & Sons, Middletown, Conn., $22,320; C. W. Blakeslee & Sons, New Haven, Conn., $22,634.80; Anthony Carroll, New Haven, Conn., $24,301; Patrick Maher, New Haven, $25,042.50; Laurence O'Brien, New Haven, $25,219; Austin & Caldwell, New Britain, Conn., $28,194. The contract was awarded to A. Brazos & Sons at the following prices: 280 ft. of 36-in. brick sewer, $6 per ft.; 2,100 ft. of 30-in., $4.35 per ft.; 1,270 ft. of 24-in., $3.50; 270 ft. of 18-in. pipe, $2.60; 50 ft. of 15-in., $2; 600 ft. of 12-in., $2; 320 ft. of 9-in., $1.90; 600 ft. of 12-in. culvert, $1.25; 24 catch basins, $100 each; 26 manholes, $50 each; total, $22,330.——No. 2: Edward McManus, Waterbury, Conn., $4,411.70; Anthony Carroll, $4,419; Laurence O'Brien, $4,775; J. H. Connor, New Haven, $4,970; C. W. Blakeslee & Sons, $5,149.20; Patrick Maher, $5,288.50; A. Brazos & Sons, $5,477.50; Austin & Caldwell, $5,830.50. The contract was awarded to Edward McManus, at the following prices: 130 ft. of 24-in. brick sewer, $4; 680 ft. of 15-in. pipe, $1.62; 920 ft. of 12-in., $1.53; 150 ft. of 12-in. culvert, $1.15; 7 catch basins, $115 each; 9 manholes, $45 each; total, $4,411.70.——No. 3: C. W. Blakeslee & Sons, $9,765.70; A. Brazos & Sons, $9,815; Patrick Maher, $11,394; Austin & Caldwell, $11,425; Anthony Carroll, $11,455; Laurence O'Brien, $11,820; Harris & Maguire, Brooklyn, N. Y., $12,352.10. The contract was awarded to C. W. Blakeslee & Sons at the following prices: 1,040 ft. of 36-in. brick sewer, $5.70; 590 ft. of 30-in., $4.23; 50 ft. of 24-in., $3.90; 150 ft. of 12-in. culvert, $1.18; 5 catch basins, $100; receiving basin, $20; 9 manholes, $50; total, $9,765.70.

Kansas City, Mo.—The City Engineer has awarded contracts as follows:—Sewer in district No. 103, P. McDonald: 12-in. pipe, 60 cts.; manholes, $40; rock excavation, $5; total, $1,016.60. Sewer in district No. 43, James Pryor: 18-in. pipe, 65 cts.; 12-in. pipe, 32½ cts.; manholes, $30; catch basins, $40; rock excavation, $3 per cu. yd.; rubble masonry, $4 per cu. yd.; total, $2,095.12. Sewer in district No. 126, J. T. Kelley: 33-in. brick, $3.60; 30-in. brick, $3.32; 27-in. brick, $3.15; 21-in. pipe, $2.71; 12-in. pipe, $2.70; rubble masonry, $3.50 per cu. yd.; rock excavation, 2 cts. per cu. yd; manholes, $46 each; catch-basins, $37; lumber, $15; total, $33,656.01.

Stone.—The following proposals for furnishing and placing stone on the breakwater at Bar Harbor, Me., have been received by Lieut.-Col. JARED A. SMITH, U. S. Engineer Office, Portland, Me.: George M. Heelon, Green's Landing, Me., $1.23 per ton: J. A. Hamilton & Rufus A. Soule, Chebeague, Me., $1.87: H. M. Sargent & I. H. Webber, Chebeague, Me., $2 for top and slopes, $1.86 for core: Thomas A. Rowe, Boston, Mass., $1.92: L. E. Lunt & S. Cleaves, Portland, Me., $1.94½.

Lock Pit.—The contract for the lock pit at the Sault Ste. Marie canal has been awarded by Col. O. M. POE, U. S. Engineer Office, Detroit, Mich., to Collins & Farwell, of Detroit, at $220,670. (The prices of the bids were given on p. 201.)

Depot.—The contract for the new Connecticut & Western depot at Hartford, Conn., has been let to H. W. FOX & Co., of that city. Work will be commenced at once and completed by July. The cost will be about $16,000. BROOKS M. LINCOLN is the architect.

Pipe and Specials.—Seven proposals for about 2,000 tons of 20-in. cast-iron water pipe and 50 tons of special castings were received March 6 by the Water Commissioners, New London, Conn.: No. 1, $24.95 per net ton for pipe, $52.50 per net ton for specials, $52,525. No. 2: $52.19, $50, $52,880. No. 3: $24.50 (A) and $23.80 (B), $46.50, $50, 391.90. No. 4: $26, $50, $54, 500. No. 5: $53 for specials. No. 6: $26.78, $50, $56,000. No. 7: $24.90, $50, $52,300.

Dikes.—***Delaware River.***—The following proposals for a pile dike between Fisher's Point and Petty's Island, were opened March 8 by Lieut.-Col. H. M. ROBERT, U. S. Engineer Office, Philadelphia, Pa.: Davis & Irwin, Philadelphia: 17,100 lin. ft. of Delaware pine pile, 14¾ cts. per lin. ft.; 560 ft. of white oak piles, 25 cts.; 62,000 ft. B. M. of pine wales and angle blocks, $35; 15,000 lbs. of wrought-iron, 3¾ cts. per lb.; 2,000 lbs. of drift bolts, 3 cts. per lb.; $5,379.75. Henry Nevoling, Philadelphia: 14½ cts., 25 cts., $37, 4 cts., 3 cts., $5,573.50. Van Houton & Cummings, New York: 18 cts., 30 cts., $37, 4 cts., 4 cts., $5,707.

Rappahannock River.—The following proposals for dikes and mattresses were opened March 1 by S. T. ABERT, U. S. Engineer Office, Washington, D. C.: G. E. Cole & J. W. Mills, Fredericksburg, Va., $6.80, $5.45, and $5.85 for Classes 1, 2, and 3, (highest): G. E. Ward, Richmond, Va., $4.53, $3.45, and $2.65, (lowest): A. Kishpaugh, Fredericksburg, $6.31, $4.23, $3.82: D. S. Howell, Munroe, N. Y., $4.62, $4.21, $3.77. O. Patterson, Baltimore, Md., $3.50, $5.75, $3. N. Gardner, Fredericksburg, (informal).

PROPOSALS OPEN.

Paving.—Granite block paving. J. A. JOWETT, City Engineer, Nashville, Tenn.

Electric Light.—Furnishing not less than 60 arc lights for 1 year. DAVID BURTON, Chairman of Joint Committee on Lamps, Providence, R. I. March 18.

Bridges.—Three Pratt truss combination highway bridges across branches of the Roaring Fork river; spans of 79 ft. 4½ ins., 63 ft. 6 ins., and 95 ft. Separate bids for masonry piers and pile crib piers filled with stone. THOS. W. LEONARD, Clerk of the County Commissioners, Glenwood Springs, Col. March 18.

Sewers and Stone.—Pipe sewer, 780 lin. ft. of 12-in.; man-holes, concrete, etc. Also trap-rock, granite and screenings. THE PARK COMMISSIONERS, 49-51 Chambers St., New York City. March 20.

Timber.—White oak and white pine timber for the dam at Lagrange lock, Illinois river. Capt. W. L. MARSHALL, U. S. Engineer office, Chicago, Ill. March 20.

Street Work.—Regulating; granite block and trap block paving. THE COMMISSIONER OF PUBLIC WORKS, 31 Chambers St., New York City. March 21.

Bridge Substructure.—Piers and abutments of bridge across the Schuylkill river at City Ave. Plans and specifications on file. J. VAUGHAN MERRICK, City Avenue & Germantown Bridge Co., 251 South Fourth St., Philadelphia, Pa. March 21.

Dredging.—In the North river, between 77th St. and 80th St.; 25,700 cu. yds. THE DOCKS COMMISSIONERS, Pier A, North river, New York City. March 22.

Paving.—Stone paving on the approaches to the Seneca St. bridge. W. P. RICE, City Engineer, Cleveland, O. March 23.

Railway.—Construction of 6 miles of railway. J. B. HOGG, Chief Engineer, Port Townsend Southern Ry., Port Townsend, Wash. Ty. March 23.

Paving.—Cedar block and cobble-stone paving. Estimated cost of work, $21,000. JOHN J. GRANVILLE, City Engineer, East Saginaw, Mich. March 23.

Street Lighting.—Gas and electric lighting for the year beginning May 1. THE GAS COMMISSION, 31 Chambers St., New York City. March 27.

Paving.—Block paving, brick sidewalks, and granite curbing. THE STREET COMMITTEE, Nantucket, Mass. March 27.

Paving Material.—Sheet asphaltum, Sioux Falls granite, Colorado sandstone, wooden blocks, or brick. Specifications on file. St. A. D. BALCOMBE, Chairman of Board of Public Works, Omaha, Neb. March 29.

Street and Sewer Work.—Furnishing and laying curbing and flagging; furnishing brick and laying sidewalks; furnishing materials and constructing sewers. For terms of 1, 2 and 5 years. Plans and specifications at the office of R. M. CLAYTON, City Engineer, M. MAHONEY, Commissioner of Public Works, Atlanta, Ga. April 1.

Buildings.—Buildings, railway track scale, railway turntable, etc. Col. J. M. WHITTEMORE, U. S. A., Watervliet Arsenal, West Troy, N. Y. April 3.

Breakwater.—At Ashland harbor, Wis., about 3,861 ft. pile cribs with rock ballasting. Major QUINN, U. S. Engineer office, Duluth, Minn. April 5.

MANUFACTURING AND TECHNICAL.

Granite.—The Booth Brothers & Hurricane Isle Granite Co. has been incorporated, with a capital stock of $250,000, for the purpose of carrying on an extensive quarrying and contracting business in rough and cut granite It is a consolidation of two important concerns. Messrs. Booth Bros. have been established in New York for 18 years, having their office at 60 Bank St., their yard at 113th St. and Avenue A. and their quarries at Millstone Point Niantic, Conn., and Long Cove, Tenants Harbor, Me. The 'Hurricane Isle Co.' has also been in business for a number of years. The officers of the new company are: President, WILLIAM BOOTH; Treasurer, JOHN BOOTH; Secretaries, JOHN DONALDSON and CHAS. S. FERGUSON; JAMES SHANDS and WM. S. WHITE are also among the incorporators.

All these gentlemen are well known in the trade, and all bring important connections to the new company. The office remains at 60 Bank St., and the New York yard at 113th St. and Avenue A. The company will operate about half a dozen of the largest granite quarries in the country, mostly in the State of Maine, the others being in Connecticut and Rhode Island. This consolidation of different interests makes the company one of the largest concerns in the business, and its facilities and arrangements are excellent.

Contractors' and Mine Supplies.—Ryan & McDonald, of Waterloo, N.Y., and Baltimore, Md., have shipped 3 carloads of construction cars to Virginia and South Carolina, and a double drum hoisting engine to Wilkesbarre, Pa. They have a large number of orders for cars on hand and are receiving many new orders. The works are running full time.

The Suits of the Hyatt Pure Water Co. against the Jewell Pure Water Co. for infringement of patents have been dismissed in the U. S. Court of the Northern District of Illinois, before Judge Blodgett, at the plaintiff's cost.

Railway Material.—The Lexington Terminal Ry. Co., of Lexington, Ga., wants rails, and cars; also a powerful locomotive for sharp curves and heavy grades. Line 3 miles long. President, HAMILTON MCWHORTER.

The Reynolds & Henry Construction Co., of Monroe, La., will purchase flat cars and 2 locomotives for railway construction work.

New or second-hand 16-lb. iron rails and 2 cars are wanted by A. L. RANDALL, of Dallas, Tex., for a street railway 1 mile long to be built near Forth Worth.

At Jacksonville, Fla., the city authorities will build a tramway to the sand hills to haul sand for filling.

About 100,000 ties are wanted by J. A. FICKINGER, of Fairmont, W. Va., for the railway from Fairmont to Parkersburg.

The Virginia Coal & Coke Co., of Shaw, W. Va., wants steel rails and ⅞-in. wire rope.

Wire Tramway.—A plant for conveying stone, etc., in buckets on a rope tramway across the river, is wanted by J. T. MARTIN, of Buchanan, Va.

Locomotives.—The Schenectady Locomotive Works, of Schenectady, N. Y., have shipped 2 engines to the Union Pacific.

The Rogers Locomotive Works, of Paterson, N. J., have an order for 7 heavy consolidation engines for the Louisville & Nashville; they are for its coal trains.

The West Virginia Central & Pittsburg Ry. has ordered 2 new engines.

The Georgetown & Western Ry. has added 2 new locomotives to its equipment.

Cars.—The U. S. Rolling Stock Co., of Anniston, Ala., has an order for 300 coal cars and 700 fruit cars for the Georgia Central.

The Barney & Smith Mfg. Co., of Dayton, O., is building 20 emigrant sleeping cars for the Northern Pacific.

Pardee, Snyder & Co., of Watsontown, Pa., are building 100 box cars for the New Jersey Central.

Osgood, Bradley & Sons, of Worcester, Mass., have an order in hand for the Knox & Lincoln.

The Pullman Palace Car Co., of Pullman, Ill., is building 107 vestibule cars.

The Dauphin Car Works, of Dauphin, Pa., are building 150 freight cars for the Philadelphia & Reading.

The Middletown Car Works, of Middletown, Pa., are building 350 freight cars for the Philadelphia & Reading.

The St. Charles Car Co., of St. Charles, Mo., has an order for 20 passenger cars for the Union Pacific, and a number of flat cars for the Cleveland, St. Louis & Kansas City.

The Harrisburg Mfg. Co., of Harrisburg, Pa., is building 150 box cars for the New Jersey Central.

The Steel Car Co. proposes to establish works at Louisville, Ky. Major THOMAS H. HAYS is interested.

Rock Drills.—The Ingersoll-Sergeant Rock Drill Co. has been formed by the consolidation of the Ingersoll Rock Drill Co. and the Sergeant Drill Co. The company has sole control of the "Ingersoll" and "Sergeant" drills, air compressors, coal mining machine, stone channeling machine, gadder and quarry bar. It also furnishes prospecting drills and all kinds of plant, boilers' derricks, engines, wire rope, blasting apparatus, etc., for mining, tunneling and quarrying. The "Ingersoll-Sergeant" air compressor is an improved pattern of the old "Ingersoll" compressor. Its special features are—an improved form of air cylinder, an automatic air regulator, and new swivel crossheads, besides several other improvements in the details of construction. The air end is made to last equally as long as the steam end. No water is admitted in the air cylinder, but the cooling is effected by an improved form of jacket, and an oil-cup admits automatically a constant supply of oil, keeping the cylinder thoroughly lubricated and preventing the wear which is so common in air cylinders. The automatic air regulator controls the admission of steam and the discharge of compressed air to such an extent that the power applied to the compressor is regulated in proportion to the work it is called upon to perform.

Garbage Cremation.—The Board of Public Works of Jacksonville, Fla., has recommended the building of a crematory at a cost of $3,000.

The Shreveport Concrete Co. has been organized at Shreveport, La., by H. S. SHORT and others, to lay sidewalks, etc.

Buildings.—The Baltimore & Ohio has awarded the contracts for a round-house 70 ft. diameter and a freight house 80 x 106 ft. to David Lee, of Newark, O., at about $40,000.

Electric Signal.—The Philadelphia & Reading is experimenting with a new electric bell signal for crossings, and if they prove satisfactory will probably use them at all grade crossings where no flagmen or gates are provided.

Steel Process.—The Michigan Steel Co. is erecting at Detroit, Mich., a plant to manufacture steel on the process invented by G. L. REBERT, of France, and improved by J. W. BOOKWALTER, of Springfield, O. Plants will soon be in operation at Chester and Springfield. The process is said to be an improvement on the Bessemer process, the blast coming from above instead of below. All the machinery will be operated by hydraulic power. The Detroit works will be in operation in about 3 months, and will have a capacity to turn out about 150 tons per day.

Flexible Car Axle Box.—The American Railway Equipment Co., of New York, manufactures the Stearns axle box, in which a bearing plate rests on 4 steel balls 1½ ins. diameter; each ball lying in a hollow in the top of the box and the lower side of the plate having similar hollows. The arrangement allows of a longitudinal play of ⅜-in., and a lateral play of ⅛-in. in the pedestal or truck frame jaw. This axle box has proved satisfactory in service.

Machine Shops.—The Union Pacific will commence work this month on the new shops at Cheyenne, Wyo. About $450,000 will be expended on the buildings and machinery.

The Burlington & Missouri River will build machine and repair shops at McCook, Neb., at a cost of about $100,000.

Sale of Iron Works.—The property of the Nashville Iron, Steel & Coal Co. will be sold March 23 by the assignee, ROBERT L. MORRIS, of Nashville, Tenn. The plant includes blast furnaces, hot blast stoves, boilers, blowing and hoisting engines, tanks, and all appurtenances and fixtures; also a complete charcoal and wood alcohol plant, buildings, railway tracks, etc.

The Kirkwood Shaking Grate.—The shaking and dumping grate manufactured by Thomas Kirkwood, of New York, has been in use for some time on the ocean steamer *Noordland* of the Red Star line, and has given very satisfactory results. This grate is in very extensive use in furnaces of all kinds and sizes, and gives universal satisfaction. Pea coal can be successfully used as fuel upon it. During February, 20 sets were put in at different works, public buildings, and residences in New York, Brooklyn, and Philadelphia; including the new Army Building in New York and the Edison Electric Light Works at Philadelphia

BRIDGES AND CANALS.

Bridge Notes.—*Holyoke, Mass.*—City Engineer ELLSWORTH has been instructed to prepare plans and specifications for the Dwight St. bridge. The bridge over the Connecticut river to South Hadley Falls will probably be built this year. The Willimansett bridge question is as yet unsettled. A new bridge at Cabot St. is also projected.

Brooklyn, N. Y.—A new bridge over Newtown creek at Maspeth Ave. is being agitated for.

Lyons, N. Y.—The Village Board has decided to commence work on the lift bridge over the canal at Genesee St. as soon as the weather permits.

Laurel, Md.—The contract for bridge piers has been awarded by E. PHELPS to RAY COLBY, agent of the Groton Bridge Co., at $500.

Wheeling, W. Va.—The Wheeling & Harrisburg Ry. Co. has submitted to the city plans for a bridge over the creek at 17th St.

Fairmont, W. Va.—The Monongahela River Ry. Co. has located a bridge over the West Fork river at the Yellow Rock ford. Proposals for masonry were received by Chief Engineer FICKINGER from Blodgett & Co., of Parkersburg; Steere & Co., of Parkersburg; Bennet, Tabbott & Co., of Fairmont; and McDonald & Fisher, of Fairmont. The contract was awarded to Blodgett & Co., and the work is to be completed by June.

Jeffersonville, Ky.—The location of the Jeffersonville bridge, in which Mr. DENNIS LONG and others are interested, has at last been finally decided, and it is probable that definite steps toward its construction will be taken at once. On March 4, Secretary of War ENDICOTT, just before he stepped out of office, signed the order locating the bridge at Mulberry St. in Jeffersonville.

Montezuma, Ga.—A contract for an iron bridge will be let shortly. For particulars address R. O. ENGRAM.

Alton, Ill.—J. E. WILLARD, sub-contractor for the building of the piers of the Alton bridge of the Cleveland, St. Louis & Kansas City road, was notified Feb. 28, by a telegram from New York, to suspend work until further orders. No reason for the suspension was given.

La Crosse, Wis.—A council committee has gone to Dubuque and Nebraska City to inspect the bridges there, before adopting plans for the bridge at La Crosse.

Authorized Bridges.—Bills have passed the House of Representatives authorizing bridges over the following rivers: Senate bill to authorize the construction of a bridge across the Missouri river near Kansas City. For bridges across the Arkansas river, near Cumming's Landing, Ark.; across the Mississippi, between Wisconsin and Minnesota; across the St. John's river, Fla.; across the Tensas river, La.; across the Missouri river between Leavenworth, Kan., and Platt County, Mo.; across the Ouachita river, La.; across the Kentucky river; across Young's bay, Ore.; across Bayou Bartholomew, La.; across the Mississippi at La Crosse, Wis.; across Green and Barren rivers, Ky.; across Osage river, Mo.; across the Mississippi at Lyons, Ia.

Canals.—A project is on foot to connect the Allegheny river and Lake Erie by a canal to cost $12,000,000. This would make a navigable stage in the river the year round.

There is a rumor afloat that a company has been organized to cut a canal from the prairies east of Sumterville, Fla., to Center Hill, for the purpose of draining the many ponds and prairies in the scope of country that it would pass through. This would reclaim many thousands of acres of land that would be equal to the richest Okeechobee reclaimed lands.

The Florida Coast Canal Co., of St. Augustine, Fla., announces that within 3 years 300 miles of canal from St. Augustine to Biscayne bay will be completed. The water-way from head of Halifax river to Jupiter inlet will be open to commerce April 30, 1889. Mr. JOHN W. DENNY is president of the company.

ELECTRICAL.

The Loomis Electric Mfg. Co. has opened new offices in the Welles Building, 18 Broadway, New York City, and is prepared to take orders for installing electric light plants. The company owns all the inventions of Mr. OSBORN P. LOOMIS, covering an absolutely automatic dynamo and a variety of improved electrical appliances. The dynamo is particularly adapted for use in theatres, public buildings, central stations, manufacturing establishments, etc., as any number of lights may be turned on or off at will, without affecting the brilliancy of the remaining lights, and without any attention being paid to the dynamo, thus dispensing with the services of a constant attendant; and, owing to its instantaneous self-regulation, the life of the lamp is materially lengthened.

Galveston, Tex.—The following proposals for lighting the city for 5 years from May next have been received by Mr. REYMERSHOFFER, of the Electric Light Committee:

Brush Electric Light & Power Co., Galveston; city to rent lights: 150 arc lights of 2,000 c. p. each, moonlight schedule, $120 per lamp per year; all night schedule, $130. Incandescent lights; 16-c. p., moonlight schedule, $24 per light per year; all night schedule, $26; 25-c. p., moonlight schedule, $28; all night schedule, $30. For lighting city buildings, 1 ct. per lamp per hour.

Thomson-Houston Electric Co., Chicago; for rent to city: 150 arc lamps of 2,000 c. p. each at $135 per annum per lamp, all night schedule, and 300 incandescent lamps of 16 c. p. each for $300 per month to use at pleasure; to furnish plant outright, comprising same number and character of lights and including whole electric plant, etc., $47,500.

Galveston Gas Co.; for gas for public lighting, city to rent lights; moonlight schedule, $24 per lamp per year for buildings, $2.25 per 1,000 ft.

Marr Construction Co; of Pittsburg, Pa.; to furnish an electric plant to be run by the city: Incandescent system, 250 lamps, 16 c. p.; put up complete, $4,307.54; with 150 arc lights, 2,000 c. p. each, put up complete, $37,224.42, making a total of $41,431.96.

David Hall, representing the Western Electric Co.: 150 arc lights at $123 per annum and 250 incandescent lights at $10.45 per year. Alternative propositions were also made.

Electrical Accumulator Lighting & Power Co., of St. Louis; to put up and operate for 5 years an electric lpant, consisting of 250 incandescent lamps of 16 c. p. a

101 arc lights of 2,000 c. p. each, all complete, for $19,872 per annum; or put up said plant for the city for sum of $20,900 cash after 30 days trial; or to rent the lights for $17,000 per annum.

Wm. T. M. Moltram, of Dallas, representing the Edison Light Co.; of New York: to rent to city 500 incandescent lamps of 20 c. p. at $24 per lamp per annum; 250 of 16-c. p. at $16, or arc lights of 1,200-c. p. at $100 each per light per annum, or 800-c. p. each at $75 per annum.

Electric Light.—***Providence, R. I.***—The Narragansett Electric Light Co. will absorb the Rhode Island Co. The former company has a Thomson-Houston arc system and a Westinghouse incandescent system.

Westerly, R. I.—The council has advertised for proposals for electric lighting: 20 arc lights of 1,200 c. p. and 84 incandescent lights of 25 c. p. The Westerly Electric Light Co. has made an offer of $3,000.

Albion, N. Y.—The vote on the electric light question resulted in 636 for and 31 against.

Troy, N. Y.—The Troy Electric Light Co. has purchased a controlling interest in the Edison Light Co. Mr. A. E. POWERS is president. The company has accepted the offer of the Contracting Board for 271 incandescent lights at 43½ cts. each.

Pottstown, Pa.—The Town Council has decided to adopt an arc light system.

Roanoke, Va.—The Roanoke Electric Light & Power Co. has been organized. President, S. GRIFFIN; Secretary, W. H. STOLL. Capital stock, $25,000.

Marietta, Ga.—The Council has closed a contract with the Jenney Electric Light Co., of Indianapolis, Ind., for 25 arc lights of 1,200 c. p. each.

Van Wert, O.—The Silvey Electric Light Co., of Lima, O., has offered to put in an electric plant.

Beardstown, Ill.—The Beardstown Electric Light & Power Co. has been organized by H. EHRHARDT, G. BLEY, and W. E. MCCULLOUGH. Capital stock, $20,000.

Kansas City, Kan.—The Consolidated Electric Light Co. will put in a Westinghouse incandescent plant.

Houston, Tex.—The city has closed a contract with the Jenney Electric Light Co., of Fort Wayne, Ind.

London, Ont.—The following proposals for lighting the city with 150 lights have been received: Reliance Co. Waterford: 150 lights, at 30 cts. per light per night, on condition that the city build station, the whole plant to become property of city at the expiration of the contract. Ball Co., Section No. 1, west of Waterloo St., on 3 years' contract, 36 cts; 5 years' contract, 34 cts. Section No. 2, east of Waterloo St., 3 years' contract, 36 cts., 5 years, 34 cts. Hunt Bros.: Section No. 1, 35 cts. for 3 years contract, and 33½ cts. for 5 years. Section No. 2, 38 cts. for 3 years, and 36 cts. for 5 yrs. An informal bid was received from the Schuyler Co. Contracts were recommended to be awarded for 3 years to the Ball Co. for the eastern section and to Hunt Bros. for the western section. The council, however, has been considering the advisability of the city operating its own plant, and has called for proposals for furnishing the necessary plant, and also for proposals for lighting the city with 150 electric lights.

WATER AND MUNICIPAL.

Bay City, Mich.—Mr. C. L. DUNBAR, Superintendent of Water-Works, has issued his report for 1888. The quality of the supply was good, but in consequence of the low water level in the bay and the increased demand, an additional supply had to be drawn from the river. The pumpage was as follows: Gaskill engines, 867,471,155 galls.; quadruplex engines, 5,483,445 galls.; rotary pumps, 35,564 galls; total, 872,990,164 galls. During the year there 100¾ ft. of cast-iron pipe, and 11,603⅞ ft. of Wyckoff pipe laid; 39 valves and 25 hydrants set. There are now 4 miles 1,847¾ ft. of cast-iron pipe, 23 miles 1,711½ ft. of Wyckoff pipe, 399 valves and 215 hydrants; 215 meters and 3 motor indicators.

Waterbury, Conn.—The Board of Water Commissioners have issued their report for 1888. There have been laid altogether about 23 miles of cement-lined pipe of various sizes; of this about 10 miles have been replaced with cast-iron, leaving 13 miles in use, a large portion of which needs to be replaced. There are now about 36 miles of pipe, 310 gates, and 238 hydrants, 36 of which are private. The engineers' report on the proposed plan for increasing the water supply is given. WELTON & BONNETT are the engineers.

Atlanta, Ga.—The Water Commissioners have issued their report for 1888. The report states that there seems to be no doubt as to the purity of the city water, and as little doubt about the supply being insufficient in the future. "There seems to be strong evidence that our so-called artesian water is simply surface water, contaminated by impurities which will soon render it unfit for use; all scientific evidence in our possession tends in this direction." The Hyatt filter works satisfactorily. There are 31 miles 1,562 ft. of pipe and 389 hydrants. The total pumpage was 628,931,300. The distribution system of the artesian well supply comprises 8 miles 3,627 ft. of pipe, 26 hydrants and 33 valves. The pumpage from the well was 10,537,880 galls. Mr. WM. J. RICHARDS is Superintendent.

Mansfield, Mass.—The Water Commissioners have issued their report for the year ending Jan. 31, 1889, being their first annual report. The supply is taken from springs and pumped by two Blake engines to a stand-pipe. There are 6¾ miles of pipe, and extensions are recommended. The cost of the works was $89,376.63. PERCY M. BLAKE was the engineer.

Fall River, Mass.—The Watuppa Water Board has submitted its report for 1888. During the year there were 8,692 ft. of 6 to 24-in. pipe laid; 12 hydrants and 111 gates set; there are now 61,373 miles of pipe, 625 hydrants and 628 gates. The total pumpage was 647,279,612 galls. There are also 3,138 meters, an increase of 197 for the year. The opinion of Chief Justice MORTON in the Fall River water case is given in full. P. KIERNAN is Superintendent.

Water and Gas Works in Mexico.—The following is taken from a daily paper:—"EL PASO, Tex.,—W. A. HAVEN and JOHN J. HARDY, of St. Louis, have obtained a 20 years' franchise from the Mexican Government to supply the different cities of the republic with water and gas. They, and those associated with them, will operate as the Union Light & Fuel Gas Co. as formerly decided upon. All of the papers have now been signed, and operations will soon be commenced. The capital stock of $5,000,000, it is said, will be increased."

Monroe, Mich.—Mr. GEO. C. CROCKER, C. E., writes us that a 25 years contract has been made by the city with W. S Parker & Co., of Pontiac, Mich. The contractor will put in a water-works plant with a daily capacity of 3,000,000 galls. and there will be 125 hydrants. The city will pay $6,000 per annum for water for fire and municipal purposes, with the privilege of purchasing the works at any time within the contract limit. The contract specifies that at its expiration the works shall be purchased by the city, the value to be fixed by appraisers. Worthington duplex pumps will be used. The pumping station will be about 1½ miles from the city, on the shore of Lake Erie; a crib will be built 2½ miles from the shore and will be connected with the pumping station by 20-in. wrought-iron pipe. The population is about 6,000.

Seymour, Ind.—Proposals for the construction of the water-works were received from W. E. McMillan, of Paris, Tex.; Scovil & Irwin Co., of Nashville, Tenn.; and Thomas W. Gray & Co., of Chicago, Ill. The contract was awarded to W. E. McMillan, who will build the works with his own capital. There will be 8 miles of mains and 100 hydrants within the corporate limits. Work will be commenced at once and is to be completed by October. WILLIAM KLITCH is City Clerk.

Sewerage.—***Providence, R. I.*** The resolution for improved sewerage works was indefinitely postponed by the Board of Aldermen on account of technical informalities in the resolution. It is expected to go forward with the work at an early date.

Fulton, N. Y.—A sewerage system is projected, at a cost of about $20,240.

Flatbush, N. Y.—A bill is before the Legislature to authorize the construction of a system of sewers.

Jersey City, N. J.—Chief Engineer RUGGLES has reported to the Board of Public Works on the erection of a sewage pumping station, for the purpose of pumping all the sewage now discharged into the Hudson river, through the sewers of the 5th District. The cost of well, connections, pipe, engines, etc., is estimated at $40,918 and land at $16,000.

Baltimore, Md.—About $119,000 will be spent in extending the sewerage system.

Knoxville, Tenn.—A bill is before the State Legislature to authorize the issue of bonds for $200,000 for the construction of sewers.

Greensboro, Ala.—The city has been authorized to issue $150,000 in bonds for a sewerage system.

Hyde Park, Ill.—The trustees have been petitioned to extend the sewerage system through the district between 75th St. and 77th St.

East Portland, Ore.—A sewerage system is necessary and the question of establishing such a system is being agitated.

Los Angeles, Cal.—The mayor has urged that prompt steps be taken for the disposal of the sewage. Surveys have been made for the outfall sewer to the ocean.

Texarkana, Tex.—The new sewerage system will cost about $35,000. For particulars address the mayor.

Water-Works.—***Maine.***—Saccarappa. It has been decided to accept the offer of the Portland Water Co. to furnish a water supply.

New Hampshire.—Milford. The cost of the proposed works is estimated at $70,345.

Massachusetts.—Springfield. The Water Commissioners have awarded the contract for 25,000 ft. of tarred wrought-iron pipe, ¾-in. to 2 ins. diameter, to Oliver & Howland, of that city.—Ware. During 1888, about 1,845 ft. of 2, 4 and 6-in. pipe have been laid, and 57 services added; also 49 meters and 3 hydrants, making a total of 87 meters and 56 hydrants. The daily consumption was 133,659 galls.

Connecticut.—Manchester. The Manchester Water Co. has elected the following officers: President, WM. FOULDS; Vice President, H. H. WHITE; Secretary and Treasurer, W. H. CHILDS.

New York.—Sag Harbor. The Sag Harbor Water-Works Co. has 4 wells down 50 ft. deep and has obtained a good quality of water. Brick has been purchased for the pumping station. A stand-pipe is to be erected.—Jamaica. The Jamaica Water Supply Co. has contracted to furnish water to the Long Island Ry.—Brooklyn. Mayor CHAPIN has issued another message to the Council urging immediate action on the water-works extension.—New York. Breaks in mains occurred March 10 in Clinton Place and E. 22d St. causing extensive caving of the streets.

New Jersey.—Sea Isle City. Work on the new water-works will be commenced as soon as the weather permits.—East Orange. The East Orange Water Co. will put in a new boiler of 125 H. P. and build another reservoir.

Pennsylvania.—East Stroudsburg. A water-works franchise has been applied for by GEO. A. STAUFFER, W. O. Ross, and H. P. WOODWARD.—Selinsgrove. The water question is not yet settled.—Scottdale. There is talk of reorganizing the Scottdale Water Co.

Virginia.—Lexington. The Buena Vista Co. is having surveys made for water-works at Buena Vista.

South Carolina.—Orangeburg. The water-works are to be enlarged. For particulars address the mayor.

Georgia.—Cartersville. The Jeter & Boardman Water & Gas Co., of Macon, will begin work on the water-works this month and will complete them by November.

Florida.—Tallahassee. The vote on the water question was not taken on Feb. 18, the Council having rescinded the call for election. The Council is now negotiating with the Tallahassee Water-Works Co., which proposes to take a supply from artesian wells and pump to stand-pipe. Capital stock, $40,000. For particulars address Mr. GEO. W. SAXON.

Alabama.—Jacksonville. The works have been purchased by CHARLES MARTIN, who will extend and improve them.—Sheffield. A pumping engine of 1,000,000 galls. daily capacity has been ordered.

Mississippi.—Greenville. A new water company is to be organized by W. A. POLLOCK, HERMAN WILCZINSKI, NATHAN GOLDSTEIN, and others. It will take a contract for supplying the city with water on the same terms as those granted the former company.

Tennessee.—Pulaski. Water-works are to be established at the Martin College.

Kentucky.—Owensboro. The new pump has been received from Buffalo, N. Y., and is being erected. It will have a daily capacity of 5,000,000 galls.

Ohio.—Napoleon. The water-works company will commence work as soon as the frost is out of the ground.

Wisconsin.—Janesville. The supply of water is said to be inadequate, and not up to the franchise requirements. An investigation is being made.

Kansas.—Girard. The Girard Water-Works Co. has been incorporated by J. W. CRAWFORD, G. GOODKIND and J. JAMES, of Girard; and J. A. DUMONT, Jr., and H. E. ASHCROFT, of New York.

Texas.—New Birmingham. A New York syndicate has made a proposition to the Cherokee Land & Iron Co. to build water-works at this place.

Colorado.—Durango. A scheme to furnish water for the city by means of an artesian well has been presented to the council by A. RAPP and W. S. WEIGHTMAN. They make a proposition to supply the city with 200,000 galls. per day, and will deliver it into a reservoir to be built by the city at a cost of $5,000 per annum, 25 per cent. additional to be charged for each 1,000 population increase. The well is to be sunk on the high mesa east of the city.

Oregon.—McMinnville. A bill authorizing the city to build water-works at a cost of $20,000 has been passed by the Legislature.—Joseph. The Joseph Water-Works Co. has been organized by E. J. FORSYTHE, W. A. LESLIE, and J. N. MCCANN. Capital stock, $4,000.

Washington Territory.—Coupeville. The Coupeville Water Co. will lay its mains in the spring.—Whatcom.—The Victoria Water, Gas & Electric Light Co. has made a proposition to furnish a water supply.—Cheballs. It is proposed to bring the water from the Newaukum river by means of a flume to furnish water power, instead of by pipes. The distance is 6½ miles, with a head of 80 ft. The cost is estimated at $1,000 per mile.

California.—Porterville. The water-works are completed. The pump was furnished by the Atlas Iron Works, of San Francisco, and has a daily capacity of 60,000 galls. It is driven by a water wheel.—Santa Barbara. The Laguna Bianca Water Co. will furnish a water supply. A storage reservoir of 300,000,000 galls. capacity will be constructed and there will be a high-pressure and low-pressure service. A. S. COOPER is manager.

Nevada.—Winnemucca. The water supply is to be increased by sinking a large well below the bed of the Humboldt river.

Utah.—Ogden. The present system of water-works is said to be inadequate and in bad condition. The new Council will lay iron pipe and build reservoirs.

Canada.—Toronto, Ont. The City Council will submit on April 9 a by-law for the raising of $577,000 to extend the water-works system.—Wiarton, Ont. Messrs. Lea thorn & Harding, of London, and Mr. BURNS, of Toronto, have been inspecting the village, with a view to making bids for the extension of the water-works.